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Innovation Linkages

Strategic Networks and Alliances within the Western Australian ICT Sector

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Executive Summary

This study examined strategic networking and alliance building among firms within the information and communications technologies (ICT) sector in Western Australia. The *Centre for Entrepreneurial Management and Innovation* (CEMI), of the Graduate School of Management (GSM) at the University of Western Australia (UWA) undertook this study with assistance from the Department of Industry and Resources, although the views contained in the report are those of the author's and do not reflect the official view of the State Government. The methodology used in this study consisted of a survey of all firms identified within the WA ICT sector, as well as a series of case studies of firms within selected sub-sectors within the industry. A total of 28 case studies were examined within five potential 'clusters', namely: wireless technologies, mining software, defence technologies, e-business services and Technology Park Bentley.

The study examined networking activities along three distinct layers: 1) the production network (e.g. supplier to customer level), 2) the resource network (e.g. horizontal linkages with financial institutions or research centres), and 3) the social network (e.g. person-to-person contacts). No evidence of industry clusters within the ICT sector in WA was found, although there were strong alliances that had been formed within the production network between firms and their lead customers and key suppliers. Such alliances appear to have strengthened over recent years and were forged with partners both within WA and overseas.

Although the majority of firms in the local ICT sector are small, at least half are engaged in exporting and there is a high level of innovation intensity with just over half having a formal commercialisation process. Investment in research and development (R&D) within the sector is high and all but the very smallest firms (e.g. micro-enterprises) appear to be deriving commercial value from new product development. However, the industry lacks sufficient concentration and is somewhat fragmented with little evidence of collaboration across the resource network. This is particularly the case with respect to joint research linkages with local universities or research centres (e.g. CRC, CSIRO), where such networking was ad hoc and linkages weak. Government assistance schemes targeting R&D were viewed by many firms as overly complex and bureaucratic, with many choosing to secure such support from lead customers, particularly within overseas markets.

A common problem identified by this study was a lack of local venture capital to assist business development. Many firms had sought to secure such financing overseas. The small size of the local market had also been a major driver for firms to export. However, there were also concerns raised over the nature of government tendering policies that were viewed as detrimental to small firms. While senior managers within the ICT sector were highly active in leading innovation, developing new products and securing new market opportunities, there was a problem among most firms in securing quality managerial personnel to assist future business growth.

Recommendations for Future Action

In analysing the findings of this study the following recommendations are made for future action by the WA State Government in conjunction with the local ICT industry:

- **Identify core competencies and foster greater industry concentration in the search for clusters.** Undertake an audit of the state's ICT sector to determine the sub-sectors that can be best developed to achieve enhanced concentration of activities and specialisation for international competitiveness.

- **Create institutions of collaboration** or non-profit organizations designed to foster cooperative alliances and joint initiatives. Consideration should be given to setting up a *Western Australian ICT Institute* that may serve as a non-government, not-for-profit facilitative entity within the industry sector.

- **Identify and nurture 'cluster champions'** drawn from volunteer firms capable of serving as a focal point around which strong local production networks can form.

- **Promote development of themed innovation incubators** able to focus activities on areas of specialisation and draw in the expertise of local universities and other research centres.

- **Review commercialisation strategies** within universities, CSIRO and government agencies to assist the process of technology transfer particularly to small firms, and link research into venture capital at an earlier stage.

- **Foster communities of interest with commercial benefits** identify opportunities for collaboration around areas of common interest that will offer tangible commercial benefits to the participating firms (e.g. joint R&D and market development projects).

- **Review government tendering policies** to provide enhanced support for small firms and to allow greater flexibility to allow strategic partnering. Despite recent attempts to change policies, there remains further opportunity for improvements.

- **Review industry support schemes** to allow easier access by small firms and to reduce the overall compliance costs associated with them. The recently announced Federal Government *ICT Framework for the Future* initiative offers an opportunity for the WA ICT sector, led by the State Government to shape future support schemes.

- **Widen technology precinct-cluster area** to include not only Technology Park Bentley, but also the Perth CBD, Herdsman/Osborne Park and Nedlands/West Perth area creating a larger *Perth ICT Triangle* model anchored by Curtin University and UWA.

- **Business migration schemes** should be examined to assist the flow of skilled employees, managerial talent and inbound private investment into the local ICT sector.

- **Managerial education and investment readiness** must be upgraded within the sector and given the same level of prominence as technology, R&D and new product development.

Chapter 1

Strategic Networks and Alliances for Innovation and Enterprise

Introduction

> "Productivity does not depend on *what* industries a region competes in, but *how* it competes" (Porter, 2001).

The Western Australian economy, despite its strengths, remains highly dependent on 'traditional' industries such as mining, resources and agribusiness. It is important that the state diversify its economy into alternative industries that can generate both export revenues and future employment opportunities. One industry that has offered such promise is that of information and communications technologies (ICT), which encompasses computer software engineering, multi-media production, computer hardware and peripherals manufacturing, telecommunications, website development, computer and internet services, product distribution and servicing, and education, training and research.

The WA ICT sector has grown strongly since the late 1990s and has generated several highly successful firms that have achieved strong export sales (TIAC, 1999). However, the majority of firms within the WA ICT sector are small with the majority employing fewer than 20 persons. It is important that as many of these firms as possible grow and expand both their employment base and their market share. Further, such firms must develop a strong presence in international markets. This will require them to achieve international best practice in terms of their product and process technologies and management competencies.

A major objective of this study was to examine the linkages that exist between firms within the WA ICT sector with a view to identifying the role such networks play in enhancing innovation and competitiveness. Strategic networks offer firms the potential to increase their competitiveness through the securing enhance access to new markets or product and process technologies. Such networks and alliances also offer firms the ability to build their business capacity by access to knowledge, skills and expertise from other firms both with their own industry and in other industries. Strategic alliances and networks enable firms – both large and small – to better defend their market position though cooperative marketing and joint responses to threats from new market entrants and substitutes (Jarrett, 1998).

Background to the Study

The Centre for Entrepreneurial Management and Innovation (CEMI), undertook the study with assistance from the MBA students enrolled in the unit called *Networks and Alliances for Innovation and Entrepreneurship*. The study involved a total of six months research, including four months of fieldwork from September to December 2002.

International research into the competitiveness of industries and regions has highlighted the importance of inter-firm cooperation and networking, particularly for small to medium firms (OECD, 2000). Industrial agglomerations or 'clusters' involving the concentration of firms in related and supporting industries that both compete and cooperate for mutual benefit has been recognized as significant generators of innovation and competitiveness.

The networks and alliances generated between firms that create industrial clusters offer the potential for enhanced flow of ideas, technology transfer and product or market development. During the 1970s the success of small firms in the Italian textiles industry to cooperate in local production networks that captured a significant share of international markets, was recognized as the "Third Italy" (Isaksen, 1996). Frequently family owned these firms demonstrated a strong capacity for innovation and globalisation, successfully adapting to changing technology and increasing market competition. Italy's northern regions were the location of dynamic enterprise clusters in textiles, apparel and footwear (OECD, 2000).

During the 1980s and 1990s the importance of enterprise clustering became widely recognized with a variety of countries demonstrating similar enterprise regions to those found in Italy. Examples were cutlery industries in Solingen, Germany, silk manufacturing and carbon fibre in Japan, and the technology cluster of Silicon Valley in the United States (Gordon and Kimball, 1998). Harvard University economist Michael E. Porter further promoted the concept in his book, *Competitive Advantage of Nations* in the early 1990s. According to Porter industry clusters are:

> A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities. The geographic scope of clusters ranges from a region, a state, or even a single city to span nearby or neighbouring countries (e.g. southern Germany and German-speaking Switzerland). The geographic scope of a cluster relates to the distance over which informational, transactional, incentive, and other efficiencies occur (Porter, 2000).

The Innovation Linkages Study draws upon this well-established foundation of industrial clustering to examine the performance of the WA ICT sector in terms of inter-firm networks and alliances. Of particular interest was whether there existed in WA cooperative behaviour that might be classified as an industry cluster.

Overview of the Methodology

The study commenced with the identification of several sub-sectors within the WA ICT industry that were considered to be potential clusters. These included: wireless technologies; mining software; spatial information technologies; defence software engineering; data security technologies; multimedia and gaming software; medical imaging and environmental management software. Also of interest was the Technology Park Precinct, Bentley in the southern suburbs of Perth.

With assistance from DoIR a series of 'focal' companies were identified within each industry sub-sector. Such firms were selected for their relative prominence within the ICT industry and potential to offer insights into the networking behaviour of the industry. Focal companies are firms that are prominent within their industry and serve as a focal point for other firms in terms of supplier or customer relationships. The Italian clothing manufacturer Benetton is an example of a focal company. A key to the success of

Benetton has been its ability to develop a strong network of small to medium suppliers and distributors within whom it has established strategic partnerships both within Italy and throughout the world (Camuffo, Romano and Vinelli, 2001). Strategic networks and alliances of the kind developed by Benetton went beyond the traditional sub-contractor, supply-chain relationships and offered a reciprocal flow of ideas and capital enhancing the innovativeness and global competitiveness of the focal firm and its partners (Jarillo, 1993). The definition of strategic networks used in the study was:

> "Long-term, purposeful arrangements among distinct but related for profit organizations that allow those firms in them to gain or sustain competitive advantage vis-à-vis their competitors outside the network, by optimising activity costs and minimizing coordination costs" (Jarrillo, 1993:49).

Five sub-sector studies were undertaken in the fields of: 1) mining software technologies; 2) defence software engineering; 3) wireless communications; 4) e-business services; and 5) the Technology Park Bentley. Multiple case studies were prepared within each industry sub-sector with in-depth interviews being conducted with the managers of focal firms and some of their network partners. All interviews used a common interview protocol in which the unit of analysis was the strategic networking behaviour of the firm and its management. 'Replication logic' was used in the analysis of these case studies, with pattern matching taking place across cases to identify common behaviours among firms (Yin, 1989).

The networking behaviour of these firms was examined on three distinct levels or layers (Holmlund and Tornroos, 1997). The first was the *production network layer* – the vertical level flowing from supplier through the firm to the customer. The second was the *resource network layer* – the horizontal level involving relationships between the firm and such organizations as banks, venture capital sources, government agencies, universities and research centres and other industries. The third was the *social network layer* – the interpersonal relationships that exist between the individual managers and employees working within the firm and managers and employees from other firms and organizations.

Industrial networks consist of two or more actors performing industrial activities through mutual exchange relationships. An industrial network commonly consists of three closely interrelated and interconnected variables, which are actors, activities and resources (Holmlund and Tornroos, 1997). Actors within such networks can be individuals, groups of individuals or such formal entities as firms or groups of firms. Actors, whose activities can be of a technical, financial, legal or social nature, control resources and influence the nature of exchange relationships between other actors within the network (Johanson, 1994). Each layer of exchange relationship has its own dynamics and level of formality, although the most informal level tends to be at the social network layer and the most formal at the production network layer.

Triangulation of the data was undertaken through inter-case comparisons within each sub-sector, inter-sub-sector comparisons between the five sub-sectors, and consideration of research findings from published sources. In addition to this case study analysis, a large-scale survey was mailed to all firms located within the ICT industry database held by DoIR. This survey examined networking and innovation behaviour within firms.

The questionnaire used in the survey was based on scale items originally used in a study undertaken by the Australian Manufacturing Council (AMC) that examined linkages between Australian manufacturing firms and their contribution to innovation and growth

(AMC, 1994). Additional items were drawn from research that investigated the nature of innovation within Australian companies (Soutar and McNeil, 1993).

Prior to conducting the field survey the questionnaire was pilot tested and revised with the removal of several items considered redundant. The questionnaire was separated into nine sections that examined: 1) the importance of lead customers; 2) the importance of key suppliers; 3) the importance of joint initiatives and alliances; 4) technology transfer; 5) the value of alliances and networks; 6) the importance of innovation; 7) the process of innovation; 8) export behaviour; and 9) demographic information about the firm.

The questionnaire was mailed under cover of a recruitment letter outlining the nature of the research to 400 firms contained in the DoIR ICT firms' database. Each respondent was provided with a paid, return envelope address back to the university research team. All responses were anonymous and covering letter in instructions assured confidentiality of the information. Contact numbers for the research team were provided on the covering material to field any questions or concerns by respondent firms. The covering letter and instructions on the survey specifically requested that the CEO or senior manager of the business entity complete the questionnaire. The mail out to the initial sampling frame of 400 firms in the DoIR database yielded a total of 46 responses received (11.5 percent response rate) of which 44 were usable. A second mail out was undertaken which yielded a further 30 responses providing a final usable sample of 73 firms or an overall response rate of 19 percent.

Chapter 2

The Western Australian ICT Sector

Size and Structure of the Sector

The exact size of the ICT sector in Western Australia is difficult to estimate as it includes a diverse range of firms and other organizations such as universities and government research centres. Recent estimates undertaken on behalf of the WA Government suggest that in 1999-2000 there were around 430 firms actively engaged in the ICT sector in the state (Boche Group, 2000). This study found many firms within the DoIR database used for the mail survey had ceased to trade or did not consider themselves to be active in the sector. It is likely that the WA ICT sector has experienced a contraction since the downturn of the information technology market during 2001-2002. However, the overall picture appears to be similar to that identified in 1999 by the WA Technology and Industry Advisory Council (TIAC) which noted:

> "The 400 IT and multimedia firms in Western Australia include multinational and local companies involved in the manufacture, development or wholesaling of equipment, software or services in which the primary product is the delivery of information processing, multimedia or communications. Of these about two thirds are locally owned, the remainder are either owned by overseas or east coast interests" (TIAC, 1999:129).

Industry Sub-Sectors

Although the WA ICT sector comprises only a relatively small number of firms these are engaged in a diverse range of activities that have been classified into identifiable sub-sectors. Table 1 shows the proportion of firms identified within the sample drawn for this study that fell within these categories, and compares this with the findings of two earlier samples drawn for surveys undertaken by the WA State Government in 1998 and 2000 (Boche Group, 2000).

From Table 1 it can be seen that there are firms engaged in a wide cross-section of activities associated with ICT. There is a heavier concentration of firms involved in software production, and services suggesting a stronger focus on these areas than hardware design or manufacture. Many firms indicated that they were engaged in more than one industry sub-sector. The sample drawn for this study compares favourably with that described by the earlier surveys and shows a similar distribution across the various sub-sectors to these other samples.

Table 1: Industry Sub-Sectors in WA ICT Industry – comparison of samples

Industry Sub-sector	N	% 2002 Sample*	N	% 2000 sample**	%1998 sample**
Manufacturing of ICT equipment	12	16.7	35	25.4	15.5
Production of software	40	55.8	83	60.1	45.8
Distribution of products and software	27	37.5	83	60.1	37.4
Production of ICT services	29	40.3	113	81.9	65.8
Provision of services through application of ICT	40	55.6	75	54.3	14.8
Commercialisation of ICT	21	29.2	48	34.8	3.2
Tertiary/Education organizations	6	8.3	6	4.3	1.9
Other	6	8.3	12	8.7	4.5

* Represents the 2002 sample gathered for this study; ** Samples gathered by Bosch Group (2000).

Potential Industry Clusters

In addition to the industry sub-sectors outlined in Table 1 a further list of industry sub-sectors was identified for the purposes of this study. These categories were identified by DoIR as representing potential industry clusters within the WA ICT industry. Table 2 shows the number of firms within the study sample that indicated they belonged to these potential clusters.

Table 2: Potential clusters in WA ICT sector

Industry Sub-sector	N	% 2002 Sample*	Industry Sub-sector	N	% 2002 Sample*
Wireless technologies	18	24.7	Multimedia & game technology	10	13.7
Mining software technologies	14	19.2	Medical ICT technologies	4	5.5
Spatial science technologies	10	13.7	Environmental management	6	4.1
Defence software technologies	11	15.4	Technology Park Precinct	3	4.1
Security technologies	13	17.8	Other	24	32.9
Marine ICT technologies	6	13.7			

* Represents the 2002 sample gathered for this study;

As shown in Table 2 while there were many firms that included themselves in these sub-sector 'clusters' a relatively high proportion (33%) indicated that they saw themselves in another category entirely. It should be noted that most firms considered themselves to be operating in more than one of these sub-sectors. In addition to the sub-sectors outlined in Table 2 respondents in the sample identified the following categories:

Database technologies	Training and software education
Internet Service Provision	Software engineering (generic)
CBD data communications	Virtual Reality technologies
Telecommunications software	Bandwidth management
Network technologies	

Although these sub-sectors were identified as potential industry clusters their status as such was not automatically accepted by the research team. It was a key focus of the study to determine whether the interrelationships between firms within these sub-sectors could be recognized as genuine clusters.

Size of Firms in the ICT Sector

Within Australia firms are classified as micro-enterprises if they employ less than five persons, small if they employ less than 20 persons, medium size if they employ less than 200 persons and large if their employment base exceeds 200 (ABS, 2002). The majority of firms operating within the WA ICT sector are small. Surveys undertaken in 1998 and 2000 found that at least half of all firms within the sector employed less than 20 persons on either a full or part time basis. The average firm in the sector employed around 27 employees with about 22 full-time and 5 part time employees (Boche Group, 2000). This compares with findings from a 1995 study that found the average size of WA ICT firms was between 18 and 30 employees (TIAC, 1999).

The sample that was drawn for this study found similar results to that of these earlier surveys. Within the sample around 15 percent were micro-enterprises, 44 percent were small firms and 35 percent were medium size. Of the 6 percent that could be classified as large, one was very large, however, if this outlier is removed, the average size for the firms in the sample was 33 full-time and 3 part time employees.

If the findings of the 1998, 2000 and 2001 surveys are examined together with our survey findings the picture that emerges is one of a local ICT industry populated by small and very small firms, but dominated by a few large organizations. The implications of having an industry comprised of so many micro and small firms will be considered later in this report. However, it is important to note that small firms frequently face problems that are not as critical to their larger counterparts. Of particular importance is the lack of resources – both human and financial – that is common among small firms. This resource scarcity can restrict the firm's capacity to grow and impose additional burdens on its managers.

Length of Time in Operation

The length of time that the firms surveyed for this study had been in operation ranged from 1 year to 35 years with the average length of time being 12 years. This finding is consistent with that of the two earlier industry surveys undertaken in 1998 and 2000 that

found the average length of time WA-based ICT firms were in operation was 10 years (TIAC, 1999).

Annual Turnover

In the early 1990s WA ICT firms were found to turnover an annual volume of sales worth between $2 million and $55 million (TIAC, 1999). Locally owned firms tended to generate significantly less sales than firms owned either by foreign or inter-state interests. An examination of the annual sales turnover of firms surveyed by DoIR in 1998 and 2000, and those in the current study found similar findings. The majority of firms surveyed for this study reported annual turnovers of less than $5 million, reflecting the small size of such enterprises. The most common level of turnover within the firms sampled for this study was between $1 million and $4.9 million. Table 3 shows these results.

Table 3: Annual Sales Turnover in WA ICT sector 1999 to 2002*

Annual Turnover	% 1999-2000	% 2000-2001	% 2001-2002*
Less than $100,000	14.9	8.8	5.8
$100,000 – $250,000	6.0	11.8	13.0
$250,001 – $500,000	7.5	7.4	8.7
$500,001 – $1 million	6.0	7.4	5.8
$1 million – $4.9 million	34.3	32.4	39.1
$5 million – $9.9 million	11.9	13.2	13.0
$10 million – $49.9 million	7.5	11.8	8.7
Over $50 million	6.0	5.9	5.8
Did not trade this period	6.0	1.5	-
Total	100	100	100

* Represents the 2002 sample gathered for this study;

Ownership Structure

In 1999 it was estimated that around two-thirds of the ICT firms based in WA were locally owned with the remainder either foreign owned or owned by interests based in other Australian states (TIAC, 1999). The majority of firms surveyed for this study indicated that most of their equity was held locally. Of the 73 firms in the sample an average of 71 percent of equity was owned by WA-based shareholders, the average shareholding by other Australian owners was 13 percent, with the average foreign shareholding being 14 percent.

Some 19 percent of the firms surveyed indicated that they had an overseas parent company. Of these firms 43 percent were identified as regional headquarters for their parent firm, 21 percent were described as R&D centres and 7 percent were administrative centres. The remaining 29 percent served other functions (e.g. service and sales centres).

The overseas-owned firms are more likely to be larger than their Australian-owned counterparts. Research undertaken in 1993 found that foreign-owned firms in the ICT sector of WA had an average employee base of 30 persons as compared with only 18 among locally owned firms (TIAC, 1999). Of the firms surveyed for this study those with an overseas parent indicated an average employee base of 217 (both full and part time), as compared to Australian-owned firms that had an employee size of only 30 employees.

Exporting and Sources of Revenue

> "Compared to other Australian ICT companies the Western Australian firms tend to be more export oriented" (TIAC, 1999:39).

Just over half (52%) of the firms surveyed were engaged in exporting although, as shown in Table 4, most were apparently sourcing their income from domestic rather than export sales. This figure was comparable to the findings of earlier studies that found 55 percent of WA-based ICT firms engaged in exporting and 73 percent of 2000 revenues in the sector were sourced to domestic sales (Boche Group, 2000).

Those firms that were owned by an overseas parent were found to be more likely to export than Australian-owned firms. For example, 79 percent of firms with an overseas parent were engaged in exporting as compared to only 47 percent of firms that were not foreign owned. Firm size did not appear to matter to export behaviour with no significant differences found between exporting and non-exporting firms in terms of the number of employees engaged.

Most of the firms surveyed exported to multiple overseas markets with the most commonly cited being those in the ASEAN region (e.g. Singapore, Malaysia, and Indonesia) or North America (e.g. USA and Canada). Other significant markets included the European Union, Japan and Korea, Africa (particularly Southern Africa), China and Hong Kong.

Table 4: Sources of Revenue as a proportion of annual sales turnover

Sources of Revenue	FY 1999-2000	FY 2000-2001	FY 2001-2002
	%	%	%
Domestic sales revenues	74.4	77.4	79.3
Export sales revenues	13.4	14.7	18.1
Offshore production revenues	0.6	0.7	0.7

As shown in Table 4 despite around half of all WA-based ICT firms being engaged in export, the domestic market remains a critical source of sales revenues. The large number of small and micro-enterprises operating within the sector would help to explain this trend, although as noted, the size of the firm did not appear to be significant to differentiating exporters from non-exporters. These figures, which are consistent with earlier research findings, suggest that the industry is internationally oriented, but still has some distance to go before it is international.

Sample Reliability

Although this study drew a relatively small sample (n = 73), the comparisons with earlier research undertaken into the WA ICT-Sector in recent years with slightly larger samples, suggest that it is representative of the true population. As such the findings drawn from the study can provide meaningful results. It should be noted that this study also involved a large number of case studies being compiled using in-depth interviews with senior managers from the same firms that participated in the survey.

Chapter 3

The Production Network Layer

The Importance of Lead Customers and Key Suppliers

Cooperation and strategic networking among firms is identified as a key issue in the creation of innovation and competitive advantage. The process of 'natural selection' within any industry is likely to see the death of poorly managed or unsuccessful firms, and the survival of those that can demonstrate superior competitive advantage. However, in situations where the firms in an industry can learn to cooperate and learn from each other how to improve, the survival rate of these firms is likely to be higher (BIE, 1995). This has implications for the sustainability and growth of industries and regions.

Where firms can learn to improve – through a process of benchmarking their performance against each other – their survival rate will be enhanced. Frequently lessons and ideas must be brought in from outside the industry, however, the firm's ability increase its commercial capabilities is dependent on how well it develops new capabilities from within its own resources as well as its capacity to secure capabilities from outside. Cooperation is therefore a process of sharing and trading capabilities between firms that enhances both information exchange and the enhancement of commercial capabilities.

Conditions Necessary for Strategic Networking

The conditions that appear to be important in creating an environment for inter-firm networking and cooperation relate to the nature of the firm's customers, suppliers, products and services, how the business is transacted and a broader culture existing within the industry. Those firms that have a relatively small number of heterogeneous customers that are particularly demanding and require fairly frequent and intensive levels of ongoing communication, are more likely to engage in strategic networking (BIE, 1995). Firms with complex products, with high fixed costs or economies of scale and which are technology or innovation intensive are also more likely to network strategically.

The actual nature of a firm's transactions can also encourage strategic networking if these require high costs and frequent communications over complex issues. Finally, the sustainability of strategic networking and cooperation will depend on the culture within the industry. Ideally it should emphasize trust, openness while discouraging bad behaviour via peer group sanctions.

The Production Network Layer

Much of the commercial activity that takes place within the ICT sector involves business-to-business transactions between suppliers and customers along a vertical supply-chain or marketing channel. This type of inter-firm relationship has been described as a *production network layer* usually comprising a series of formal and informal agreements that focus on the transfer of goods and services along the supply-chain or marketing channel within each firm or 'actor' playing a specific role, usually associated with adding value to the product or service as it passes (Holmlund and Tornroos, 1997).

Such interrelationships between firms form the foundation of industrial market systems. A key consideration for firms seeking to operate within such systems is what role they intend to play that will allow them to capture as much commercial value from the activities that they perform to justify their investment of time and capital. Each firm that participates in an industry must achieve a competitive advantage by demonstrating that it has the resources and capabilities to undertake particular activities better than its competitors. Few firms can perform all the activities required within the system and therefore focus on those areas within which they posses particular strengths or competencies (Mathews, 2001).

Linkages between firms within this production network can range from arms length relationships in which there is limited communication, marginal cooperation and low levels of trust, to close-knit alliances in which the boundaries of the organizations are fuzzy. Within the latter type of relationship there is generally a high level of complexity in the level of exchange. Inter-firm communication takes place in a two-way flow that is relatively intense, frequent and at a high level. Such alliances require a substantial level of mutual trust, empathy and understanding between the various firms that participate in the industrial market system. The basis of such relationships is frequently a recognition that each firm within the network offers the other mutual benefits either by achieving enhanced cost efficiency, superior competencies in undertaking a particular activity, or access to resources that the others could not acquire alone. However, real strategic networking occurs where firms learn to respect each other sufficiently to share knowledge leading to the overall improvement in the competitiveness of the entire network (Jarillo, 1993).

The Importance of Lead Customers and Key Suppliers

While all customers are important the “Leading-Edge” or Lead Customer is considered to be the most significant. Lead customers are defined as those that are dominant in their industry and generally have above average levels of competitiveness. Such customers are frequently demanding and push their suppliers to enhanced levels of performance. Research into Australian manufacturing firms found that leading-edge customers play key roles for their suppliers (AMC, 1994). Such customers can assist firms to access new markets and through their own development generate new sales. Because lead customers are dominant players within their own industries, they are usually highly demanding of their suppliers and serve to drive the overall standard of performance within their supply chain. Further, by their own success, such customers frequently enhance the market reach of their suppliers by either providing referrals or enhancing the reputation of the supplying firm through the association.

Many lead customers assist in the enhancement of innovation within the production network by cooperating with suppliers in the development of new products or services, as well as introducing new ideas and technologies within the production process. For exporting firms, an international lead customer can serve as a source of ideas that raise the overall standard of business performance to world’s best practice. This has been found to be particularly strong among exporting firms in such areas as complex manufacturing, high technology or medical equipment. These exporters see their customer’s demands as critical to shaping their performance improvements. Maintaining close and regular personal contact with lead customers is also viewed as a critically important issue (AMC, 1994).

In addition to lead customers, the competitiveness of a firm is dependent on how well it cooperates with its suppliers, particularly “key suppliers”, or those with the ability to control the quality of strategically important components or raw materials. Unfortunately many firms do not pay sufficient attention to the value of their supplier network. A firm’s

international competitiveness will be adversely influenced if its suppliers are uncompetitive in terms of quality, speed of delivery, price or flexibility.

Cooperating with suppliers via strong partnering relationships enables a firm to secure innovative ideas and enhance the strength and quality of its products via the value chain. An examination of the way best practice firms deal with suppliers suggests that three things can be done. The first involves the firm working closely with its suppliers to demand more from them, and to enhance the overall quality of the relationship. Rather than keeping suppliers at arms length, firms should seek to bring them closely into awareness of the demands end-user customers have and the benchmarks required by suppliers to meet international best practice. Finally, a firm can seek to source from the most competitive suppliers. If it has a strong or dominant position in its industry, the firm can have a substantial influence on the overall competitiveness of its suppliers (AMC, 1994).

The majority of firms surveyed for this study had their lead customers located in WA, rather than overseas or elsewhere in Australia. As shown in Table 5 the number of lead customers per firm followed a bi-polar pattern with either one to four such customers, or in excess of six lead customers.

Table 5: Number of Important Lead Customers per WA ICT-firm

Lead Customers per firm		Nil	1-2	3-4	5-6	>6
	N	%	%	%	%	%
Customers in Western Australia	72	19.4	23.6	27.8	4.2	25.0
Customers elsewhere in Australia	70	42.9	20.0	14.3	4.3	18.6
Customers overseas	70	47.1	30.0	5.7	4.3	12.9

Many of these firms supply to WA-based customers that are themselves either heavily engaged in international markets or are branch offices for overseas owned-companies. For example, the ICT firms supplying to the WA mining industry within the mining software sub-sector, service the needs of some of the world's most globally successful firms that are major exporters. Although located within the state, these lead customers provide supplier firms with a world-class benchmark. A similar pattern can be found in the defence technologies sub-sector. While these firms supply to the local defence industry they are measured against performance benchmarks that are set against international best practice due to the close cooperation that exists between the Australian military and the military of the United States, Britain or other major powers.

Nature of the Relationship with Lead Customers and Key Suppliers

Research undertaken into the Australian manufacturing sector during the mid-1990s found that around 24 percent of firms had more than five cooperative agreements while around 30 percent had only single agreements. It was more common for firms to have between 2

and 4 cooperative agreements, usually with lead customers. Small firms were found to have less formal agreements than did their larger counterparts. However, around 50 percent of all agreements were formal in nature and 40 percent of agreements were with customers and 33 percent with suppliers (BIE, 1995).

Table 6: Number of Formal Agreements with Lead Customers and Key Suppliers among WA ICT firms

Formal agreements with Customers/Suppliers per firm		Nil	1-2	3-4	5-6	>6
	N	%	%	%	%	%
Customers in Western Australia	71	31.0	33.8	14.1	5.6	15.5
Customers elsewhere in Australia	70	51.4	22.9	5.7	4.3	15.7
Customers overseas	69	62.3	21.7	5.8	2.9	7.2
Suppliers from within Western Australia	73	39.7	27.4	16.4	2.7	13.7
Suppliers from elsewhere in Australia	72	36.1	31.9	13.9	2.8	15.3
Suppliers from your export markets	72	73.6	16.7	4.2	2.8	2.8
Other overseas suppliers	72	63.9	25.0	1.4	1.4	8.3

As shown in Table 6, there were formal agreements held between WA-based ICT firms and customers or suppliers both in Australia and overseas. The most common pattern was for firms to have either only a few formal agreements (e.g. 1-2), or many (e.g. >6). Many of these agreements were with local WA customers or suppliers.

An examination of the relationship between firm size and possession of formal agreements was undertaken using chi-square tests.[1] These tests found no statistically significant relationship between the size of firms and number of formal agreements. Similar results were found with ANOVA tests on the total number of full-time employees within the firm and number of formal agreements.[2] These findings suggest that the formalization of agreements with customers and suppliers within the WA ICT sector may be unrelated to size of firm. This would appear to be contrary to the situation within the Australian manufacturing sector described above.

Relationships between suppliers and customers, whether formal or informal, have tended to be based on short-term, price-driven considerations, usually undertaken at arm's length. Such relationships, in which prices are the most important criteria, offer little opportunity for

[1] Chi-Square tests the hypothesis that the variables in a relationship are independent. These test used a Pearson chi-square test procedure to determine if size and number of formal agreements were independent of each other at a 0.05 level of confidence.

[2] Analysis of variance, or ANOVA, is a method of testing the null hypothesis that several group means are equal in the population, by comparing the sample variance estimated from the group means to that estimated within the groups. All such tests were considered significant if below 0.05 level of confidence.

value adding and collaborative innovation. Short-term, price-driven relationships are unlikely to engender mutual empathy or trust other than what can be developed within largely legal contracts.

Research undertaken with high-technology firms in the United States during the 1990s suggests that 'fast' innovators (e.g. those with the capacity to bring products to market faster than the average), were more likely to adopt close, interactive relationships with customers or suppliers. Such firms enjoyed relationships in which there was a regular flow of technical knowledge, with both supplier and customer providing information relatively freely in a reciprocal way so as to overcome complex technical issues in the development of new products. Compared with other firms, fast innovators were more likely to communicate on a daily or weekly basis, rather than less frequently (e.g. monthly). Such firms also entered into longer-term contracts (e.g. lasting longer than a year), and with a greater willingness to vary the terms of these agreements should circumstances change (Echeverri-Carroll, 1999).

An examination of the nature of the relationships that exist between WA-based ICT firms and their lead customers and key suppliers was undertaken in the study. Respondent firms were asked to rate how they viewed their relationship with customers and suppliers using a 5-point rating scale ranging from 1 = arms length to 5 = partnership like. They were asked to rate how they saw the current situation, the situation 1 to 3 years ago and the situation over 3 years ago. This was designed to gauge an impression of how these firms viewed their customer-supplier relationships. Ideally the relationship between the firms and their customers or suppliers would be more partnership like than arms length.

Table 7: Nature of the relationship with Lead Customers and Key Suppliers over recent years

1 = arms length 5 = partnership like	Has there been a significant change in the mean score from the previous period?*	mean	Std. Dev.
Relationship with customers:			
Current situation	YES	3.54	1.079
Situation 1-3 years ago	YES	3.00	1.073
Situation over 3 years ago	-	2.46	1.216
Relationship with suppliers::			
Current situation	YES	3.23	1.178
Situation 1-3 years ago	YES	2.90	1.186
Situation over 3 years ago	-	2.35	1.205

*As measured using a pair-wise *T*-test procedure at the 0.05 level.

As shown in Table 7 there has been (at least from the perspective of the respondent firms) an improvement in the nature of their relationship with lead customers and key suppliers over the past three years for most firms. These results suggest that most firms feel that they have moved significantly from an arms length to a more partnership like relationship over time.

It is also encouraging to note that a relatively high proportion of firms indicated that their current relationships with their lead customers and key suppliers were more partnership like than arms length. For example, around 13 percent of respondent firms rated their relationship with their customers as being 1 or 2 out of 5, suggesting that they considered it to be arms length in nature. By contrast around 52 percent of firms rated the relationship either 4 or 5 out of 5, indicating that they viewed it as partnership like. This was almost the reverse of the situation, as they perceived it to be over three years previously. The situation with respect to suppliers was less encouraging with 24 percent of firms indicating an arms length relationship and 43.5 percent suggesting it was partnership like. Nevertheless the supplier relationships do seem to have improved over time.

Lead Customers and Key Suppliers Role in Enhancing Performance

The test of how beneficial a relationship with a lead customer or key supplier can be is whether or not that customer or supplier has assisted the firm to enhance its products, services or performance. This may take the form of the customer or supplier establishing high standards in order to continue offering contracts, through to close cooperation in the design and development of new technologies, products or processes.

When asked to indicate whether or not they had worked closely with their lead customers to develop or improve any of their products or services in the past, 81 percent of firms surveyed indicated that they had worked with lead customers in this way. However, these same firms were less emphatic about the relative importance of customers or suppliers in relation to driving performance enhancements. Firms were asked to rate the importance of their lead customers and key suppliers in driving up performance levels over the past five years. Attention was given to customers and suppliers located both within WA, elsewhere in Australia and overseas. Two questions were asked within the survey:

> "How important have the demands of your customers been in driving you to raise your performance over the past five years?"
>
> "How important have improvements in your key supplier's performance been in raising your performance levels over the past five years?"

As Table 8 shows, the majority of firms considered their WA-based customers to be important to driving enhancements in their performance. Further, among those firms that had lead customers located outside the state, around half considered these relationships important in driving performance. The same was not the case for suppliers. As can be seen, the only some 42 percent of firms considered their WA suppliers were important to driving their performance and the situation was even more pronounced for overseas suppliers where these were applicable.

Table 8: The importance of Lead Customers and Key Suppliers in Driving Performance over past five years

1 = little or no importance 5 = critically important		Not important	Neutral	Important	Mean	Std.Dev
	N	%	%	%		
Customers in Western Australia	68	13.2	10.3	76.5	4.00	1.246
Customers elsewhere in Australia	64	31.3	17.2	51.5	3.25	1.533
Customers overseas	55	34.5	14.5	50.9	3.20	1.544
Suppliers from Western Australia	64	35.9	21.9	42.2	2.94	1.489
Suppliers from elsewhere in Australia	64	35.9	20.3	43.7	3.09	1.477
Suppliers from your export markets	51	62.7	15.7	21.6	2.12	1.366
Other overseas suppliers	53	60.4	11.3	28.3	2.30	1.539

An examination of the relationship between the relative importance of lead customers or key suppliers in WA, overseas or elsewhere in Australia, and firm size was undertaken using ANOVA tests. This found no significant differences between firms of various sizes and how they responded to these importance ratings, suggesting that customers are important regardless of where they are located to firms of all sizes, and suppliers offer similar performance enhancements to firms whether small or large.

Of interest was the finding that firms engaged in exporting rated the importance of their WA-based customers and suppliers as highly as they did their overseas customers and suppliers. Lead customers within the WA ICT-industry appear to play an important role in helping to drive up performance through their demands for high levels of quality and service. These customers also serve as market opinion leaders, enhancing the overall credibility of the products developed by the WA firms and thereby enabling them to widen their markets. There appears to be less importance placed on key suppliers as drivers of performance, although this may be reflective of the nature of this industry, which is frequently less dependent on critical supply factors than might be the case in the manufacturing sector.

The role of lead customers in helping to drive enhancements in performance within the ICT sector was evidenced by the survey. Table 9 shows the findings from the survey where it can be seen that the majority of respondent firms recognize their lead customers played an important role in driving performance via demands for quality and service. Further, such customers also appear to serve as market opinion leaders. Around 70 percent or more of firms that responded to the survey indicated this.

Table 9: Description of Lead Customers as Performance Enhancers

1 = strongly disagree 5 = strongly agree		Disagree	Neutral	Agree	Mean	Std.Dev
Our lead customers…	N	%	%	%		
Drive performance improvements by demanding quality and service	69	10.3	16.2	73.5	3.82	1.007
Are market opinion leaders and help to gain credibility for our product	69	8.8	22.1	69.2	3.78	0.990
Are a major source of new ideas or new need identification	69	34.5	14.5	50.9	3.07	1.089
Act as development partners for ideas we have initiated	69	33.3	30.4	36.2	3.03	1.188

There was less support for the notion that lead customers could serve as a major source of new ideas or new needs identification, or that such customers might collaborate with them in developing products from ideas generated by the ICT firms. While about half the firms considered their lead customers served as a source of new ideas, only 36 percent felt their customers might collaborate to develop new product ideas. Although these findings are encouraging in terms of what they show of the relative importance placed on lead customers by WA-based ICT firms, there appears to be scope for enhanced collaboration with lead customers in new product or market development.

No significant differences (at the 0.05 level) could be found between firms that exported and those that did not in relation to how they responded to the items outlined in Table 9. Further, no significant differences could be found between firms of different sizes. This analysis suggests that these firms' perception of their lead customers does not appear to be influenced by entry into export markets or scale of operations.

Communication Patterns with Lead Customers

The strength of an alliance between firms is contingent on the frequency and quality of the communication flow between the managers and staff of the various organizations. As noted above, successful fast innovators tend to be those that maintain more constant two-way flows of communication with their suppliers or customers exchanging ideas over common problems.

The study examined the use of different media used by ICT firms when communicating with their customers, and the frequency of such communication. As shown in Table 10, the Internet and telephone or facsimile is the most frequently used media particularly on a daily basis. Not surprisingly trade shows and exhibitions were more likely to be annual events when contact with customers could occur. Of interest is the relatively high proportion of firms (34.7%) that do not make use of trade shows and exhibitions to meet customers. It also seems that videoconferencing is largely unused as a communications medium.

Table 10: Frequency of Communication with Lead Customers via Different Means

Frequency of communication		Never	Annually	Monthly	Weekly	Daily
	N	%	%	%	%	%
Face to face contact between senior managers of both firms	72	8.3	26.4	54.2	11.1	-
Face to face contact by your sales or marketing staff	72	15.3	11.1	55.6	16.7	1.4
Face to face contact by your technical or design staff	72	5.6	13.9	43.1	31.9	5.6
Trade shows/exhibition	72	34.7	58.3	6.9	-	-
Telephone/Facsimile	72	2.8	2.8	15.3	45.8	33.3
Email/Data exchange	72	4.2	1.4	8.3	38.9	47.2
Videoconference	72	87.5	4.2	5.6	2.8	-
Other (e.g. newsletters and mail)	63	90.5	1.6	4.8	3.2	-

Despite the advantages offered by data, voice and image transmission via contemporary communication media, the value of face-to-face communication remains. This is particularly the case in the transfer of complex ideas and tacit knowledge, usually involving a two-way exchange essential to the learning process (Nonaka and Takeuchi, 1995). Face-to-face communication with lead customers by WA ICT firms appears to be handled by staff at a variety of levels within the company. As shown in Table 10, in addition to the contact taking place between sales or marketing staff and customers, face-to-face contact between the technical and design staff and their lead customers took place in around 80 percent of the firms on a frequency of once a month or less. This was found to be the case for about 65 percent of the firms in relation to face-to-face meetings between their senior managers and senior managers from their lead customers.

The importance of frequent communication with customers appears to be well understood among firms in the WA ICT sector. Direct contact, either via face-to-face discussions, email or telephone/fax transmission, were generally considered to be of equal importance. As shown in Table 11, the overall importance placed on face-to-face contact between customers and staff at all levels of the firm was broadly equal. This is a positive trend, suggesting that management recognizes the value of having their technical or design staff, as well as themselves and their sales personnel in close contact with lead customers.

Table 11: Importance of Different means of Communication in relation to working successfully with Lead Customers

1 = not important 5 = critically important	Importance Ranking*	Mean	Std. Dev.
Email/Data exchange	1	4.21	0.827
Face to face contact between senior managers of both firms	1	4.15	0.920
Face to face contact by your technical or design staff	1	3.94	0.893
Face to face contact by your sales or marketing staff	1	3.76	1.213
Telephone/Facsimile	1	3.62	0.947
Trade shows/exhibition	2	2.52	1.275
Videoconference	3	1.59	1.028
Other (e.g. newsletters and mail)	3	1.37	1.075

* As measured using pair-wise *t*-tests at the 0.05 level.

Chapter 4

The Resource Network Layer

Joint Initiatives, Alliances and Technology Transfer

In addition to working within the existing business system and developing strong customer and supplier relationships, firms need to seek expanded networks to partners outside their industry sector. One area is with universities or research agencies (e.g. CSIRO). Research into manufacturing firms in Australia suggests that businesses experiencing strong growth are more likely to seek more joint initiatives seeking to leapfrog competitors by securing access to new technologies (AMC, 1994). Collaborative agreements between firms enables them to leverage resources they might otherwise not be able to develop internally, or secure access to markets that would be difficult to penetrate alone. Networks of small firms have been found to outperform large, vertically integrated firms (Jarillo, 1993).

It is common for firms engaged in joint initiatives to be involved in large or expanding markets. This is typical of export industries where collaboration is a key source of competitive advantage. Highly networked firms also tend to have complimentary interests and skills with their network partners. This is not surprising, as firms will have little reason to join forces if they have nothing in common.

Collaborative networks are also likely to emerge within industries that possess strong leadership and shared vision between leading participants. Peak industry bodies can assist in this regard by representing industry interests and facilitating information exchange. Finally, the physical proximity of firms seems to matter in enhancing networks and strengthening them.

The Resource Network Layer

Innovation within high-technology industries is contingent not only on the close interaction between firms and their suppliers or customers within the production network layer, but also requires the development of linkages across into other industries or within centres of research, sources of venture capital and other key resources. Industrial market systems that require high-technology solutions have been found to operate on three distinct levels. As discussed in Chapter 3 the first is that which takes places between suppliers and customers in relation to supply-chain linkages commonly identified as the ‘value chain’, and described in this report as the production network layer. At this level inter-firm relationships are vertical with firms establishing linkages with suppliers and customers or distributors to achieve transfer of technology and enhancement of new product developments.

The second layer is that of the *resource network*, which comprises those actors that control various resources necessary for the production process to take place (Holmlund and Tornroos, 1997). This can include firms from the first layer, but also such groups as banks, insurance companies, investment sources, transport and communications even the trade unions that can control labour inputs. Government agencies engaged in regulation

of the industry can and should be included in this layer and mapped. Knowing who is in the network and what critical resources that control is of strategic value to the manager.

Significant inter-firm relationships across this second layer help to generate industrial clusters that involve groups of firms, usually within different industries and frequently geographically proximate to one another. Such firms compete and collaborate with each other within their cluster region, stimulating product and process innovations to achieve enhanced competitiveness (Porter, 2000). This second level of operation is important within high-technology industries because it facilitates the flow of ideas, transfer and diffusion of technology and securing of critical resources such as venture financing.

Developing Technological Linkages for Innovation – Techno-economic Networks

A third level of relationship within high-technology industries is that of the *complex*. This involves the integration of firms, government agencies, research centres and regulatory regimes or public-sector procurement policies to generate *Techno-economic Networks* (TEN). These serve to stimulate relationships designed to foster technological innovation and the generation and diffusion of new products or processes. Such *complexes* are viewed as national systems of inter-organizational learning and knowledge exchange likely to enhance innovation within industries (Dodgson, 1996).

> A techno-economic network is defined as "a coordinated set of heterogeneous actors – laboratories, technical research centres, financial organizations, users and public authorities – which participate collectively in the development and diffusion of innovations, and which organize, via numerous interactions, the relationships between research and the market place" (Laredo and Mustar, 1996).

The formation or encouragement of TEN structures at a national or regional level has become a focus for many governments around the world, particularly in the European Union. Government policy makers have sought to use TEN structures to intervene in the generation of scientific innovation for enhancement of industry competitiveness (Laredo, 1996).

TEN structures are commonly built around five major *poles* out of which are three supporting pillars. The first pole is that of *Science* (S), which involves the production of certified knowledge usually via published research papers. The second pole is that of *Technology* (T). This involves the conception, elaboration and transformation of material objects that are durable, reliable and capable of being commercialised. The third pole is that of the *Market* (M). This is not so much an economic market as a community of end-users able to adopt and apply the new technology. Lying between these major poles are two *mediating* poles, the first of which is the *Development and Commercialisation* (TM) comprising production and distribution activities capable of delivering the technology into the end-user market. The second is the *Transfer* (T) pole that specializes in connecting scientific research to technology applications. While the TEN is comprised of actors (e.g. scientists, engineers, firms, R&D centres), these only work effectively via collaborative exchanges to diffuse the knowledge and technologies (Laredo and Mustar, 1996).

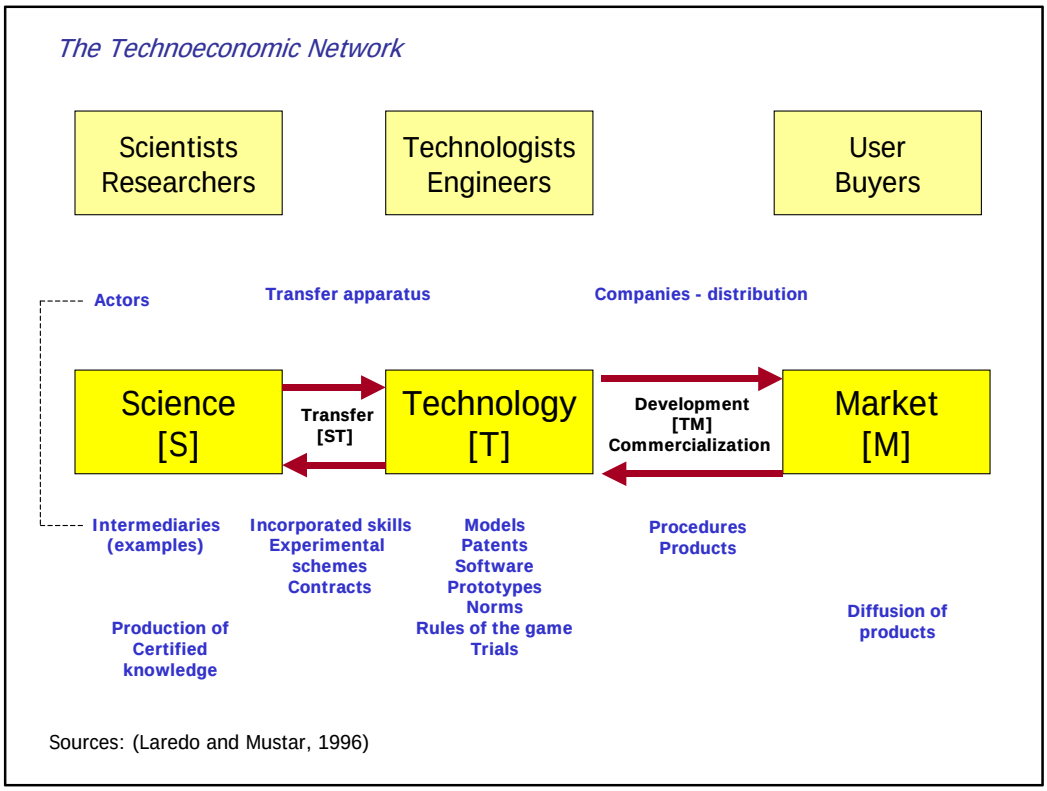

Figure 1: The Techno-economic Network

The general organization of a TEN structure is illustrated in Figure 1. It should be noted that scientific research forms the basis for the creation of technologies that can ultimately be commercialised and placed into the market. However, this commercialisation pathway requires the interaction of a large number of actors ranging from the scientific community, who are often located within university or government agencies (e.g. CSIRO), through technology engineers and buyers, who are commonly located in the private sector.

A challenge for those seeking to tap the full potential of TEN structures is to overcome the inherent cultural barriers that exist between the different actors located within the network. Technological research is commonly mapped on a continuum from fundamental, through strategic to basic technological research. Such research remains removed from the market and is general difficult to appropriate for commercial purposes. The aim of most pure or basic scientific research is non-commercial and viewed as a public good. It is generally undertaken by publicly funded research agencies (e.g. CSIRO or universities) and seeks to extend knowledge and share this among colleagues within the same scientific communities. The output from such activities is published articles, feasibility studies or simulations that can be publicly disseminated.

It is only when scientific research becomes formulated into models, patents or norms that it can be transformed into more applied technical research and development. Such research can then be targeted toward end users rather than other scientific colleagues. To make such research of value requires the production of prototypes and pilot studies to

generate first generation products. Along this path are the development of new dominant designs and the eventual commercialisation of the scientific output. Such activities can be commercialised by private sector investors and eventually placed into full-scale production.

The Research Triangle of North Carolina – A TEN Structure in Action

An example of how a TEN structure can work is the "*Research Triangle*" of North Carolina in the United States. This is considered to be one of the most successful planned science parks in the world (Porter, 2001). This highly successful science and technology park covers approximately 7,000 acres of land, housing some 45,000 people and 150 organizations.

Surrounding the science park are three research universities: North Carolina State University (NCSU) at Raleigh, the University of North Carolina at Chapel Hill (UNC-Chapel Hill), and Duke University in Durham. These three universities encompass world-class scientific research and education that compliment the work of other research centres located within the Research Triangle Park. Of note are the North Carolina Biotechnology Centre (NCBC), the Microelectronics Centre of North Carolina (MCNC), the US Environmental Protection Agency (USEPA), the National Institute of Environmental Health Sciences and the Research Triangle Institute.

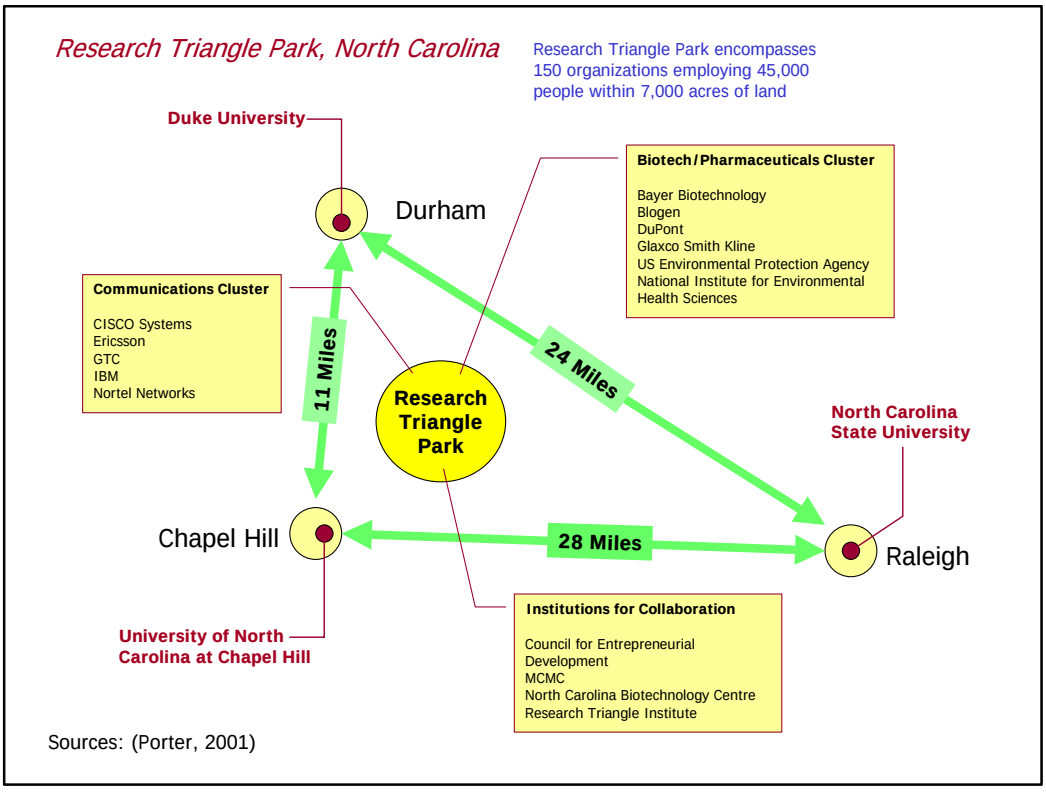

Figure 2: The Research Triangle Park, North Carolina, USA

As illustrated by Figure 2, the Research Triangle technology precinct is bounded by three cities with three research universities in close geographic proximity. While collaboration between the three universities had not been characteristic prior to the formation of the science park, their ability to interact with the other key non-university research centres, and with the research centres of major private sector firms, has all contributed to the success of the Research Triangle. In fact the close geographic proximity of the three universities to the science park has been attributed to the success of the technology transfer that has taken place there (Porter, 2001). However, simple geographic proximity alone is insufficient to create innovation of the kind seen in the Research Triangle. Many science parks have languished despite being close to large universities. A critical factor in the success of this United States model has been the existence of facilitative agencies or institutes of collaboration such as the Council for Entrepreneurial Development, the Research Triangle Institute and the North Carolina Biotechnology Centre.

The Requirements for an Effective TEN Structure

The lessons from the Research Triangle Park and other TEN structures around the world are the need for close collaboration between all key actors within the network. Geographic proximity appears to be an important element, despite the availability of modern communication and transport systems. Also critical is the existence of facilitative agencies or institutes of collaboration that are designed to draw the various actors together. At least three key areas require attention in the development of effective TEN structures: 1) commercialisation strategies; 2) venture capital strategies; and 3) ongoing education strategies (Devol, 2000).

Commercialisation strategies

Within the area of commercialisation there is a need to unlock the often-secretive world of research centres and permit the flow of technologies from one organization to another. This problem is frequently caused by difficulties in securing acceptable legal agreements over the control of valuable intellectual property held by universities and other research centres. Also of value is the creation of public-private agencies able to enhance commercialisation.

In Australia this has been attempted at the national level through the Cooperative Research Centres (CRC) program designed to link universities, government and private sector firms together for scientific research and subsequent commercialisation. Since its establishment in 1991, the CRC program has sought to enhance commercialisation within Australia by drawing together university, government and private sector researchers with financial support from the Federal Government to strengthen the long-term collaboration between such organizations (Mercer and Stocker, 2000). There are many other programs initiated by both federal and state government agencies that seek to enhance collaboration among these actors, while simultaneously stimulating enhanced innovation and technology transfer (ISR, 2001).

Venture Capital Strategies

Venture Capital is often essential for the establishment and growth of high-technology firms. Because such investments are frequently high risk, there is commonly a gap in the market and many firms find it difficult to secure early-stage venture capital. Governments can assist by providing such funds. Australia has sought to do this with such schemes as the Building on IT Strengths (BITS) Program (targeting ICT firms) and the Innovation Investment Fund (IIF). In addition to such formal venture capital funds, there is a need for

private "*Angel*" investors, but such people need to be educated to know how to evaluate high tech deals. Australia is a relatively small market and the total pool of venture funding is also small by world standards. The unique characteristics of Australia's venture capital environment has led some commentators to call for greater, rather than less government intervention, particularly in relation to such initiatives as tax incentives to encourage greater investment in local high-technology industries (Ferris, 2001).

Ongoing Education Strategies

Finally, ongoing education is important in the creation of high technology industries. There is a need to continually upgrade the skills of technicians and engineers. Universities can assist by offering entrepreneurship courses and creating technology incubators to enhance the formation of new firms (Devol, 2000). The strategic goals or plan of the high technology sector should be widely communicated to foster collective interest and attract new investment and innovation. While competition is healthy within any industry, care should be taken to avoid the creation of dysfunctional competing spheres of influence that serve to fragment and weaken efforts. This is particularly the case in industry sectors that are small and still under resourced at the regional or national level. Joint development in commercialisation should be a feature between private and public sector agencies.

Joint Initiatives and Alliances within the WA ICT Sector

Development of joint initiatives and alliances with other firms – either vertically or horizontally across the production network layer or resource network layer – offers an opportunity for enhanced innovation, product development, process improvements and market development. As noted above, this type of collaboration can play a significant role in innovation. The survey examined both the number of initiatives ICT firms possessed with local, national and international partners, and the overall importance of these initiatives and alliances to enhancing the firm's performance.

As shown in Table 12, the most common joint initiatives were found in the areas of marketing and promotion, product development and product research. Such alliances were found to exist fairly evenly at both the local, national and international level. These figures suggest that the WA ICT sector has developed national and international linkages for business development, and are just as likely to look overseas as interstate for such alliances. This is evidenced in the area of venture capital raising where such alliances were as common at the international level as they were at the local level. It seems that many firms in the WA ICT sector have either one or two joint initiatives and consider them to be quite important to their performance.

Table 12: Engagement in Joint Initiatives and Alliances for Enhanced Performance

Joint initiatives and alliances by type, number and level of importance	With WA partners	With national partners	With overseas partners
Product Research	(n=26) 35.6%	(n=22) 30.1%	(n=21) 28.8%
Average number:	2	2	1
Mean importance rating:	3.79	3.52	3.76
Product Development	(n=36) 49.3%	(n=25) 34.2%	(n=25) 34.2%
Average number:	1	1	1
Mean importance rating:	3.60	3.46	3.75
Process R&D	(n=15) 20.5%	(n=10) 13.7%	(n=14) 19.2%
Average number:	1	1	1
Mean importance rating:	2.67	3.00	3.54
Production links	(n=17) 23.3%	(n=11) 15.1%	(n=13) 17.8%
Average number:	2	2	1
Mean importance rating:	2.68	3.25	3.33
Export Distribution	(n=9) 12.3%	(n=7) 9.6%	(n=18) 24.7%
Average number:	1	2	1
Mean importance rating:	2.85	3.13	3.94
Marketing & Promotion	(n=32) 43.8%	(n=27) 37.0%	(n=25) 34.2%
Average number:	2	1	1
Mean importance rating:	3.18	3.35	3.57
Venture capital raising	(n=11) 15.1%	(n=6) 8.2%	(n=11) 15.1%
Average number:	1	1	1
Mean importance rating:	2.92	3.00	3.42

Factors Constraining Further Development of Joint Initiatives and Alliances

The capacity of the ICT sector to develop future joint initiatives and alliances are likely to depend on the benefits such initiatives offer to firms, and the negative impacts – if any – that these might have. Given the large number of small firms that comprise the ICT sector in WA such initiatives offer the potential for enhanced performance, as small firms can frequently leverage such networks to overcome inadequacies in their own resources and capabilities (Jennings and Beaver, 1997). Research into the strategic networking of small firms in Australia suggests that key factors likely to inhibit the development of joint initiatives and alliances are concerns by managers and owner-managers that such collaboration is risky (Dean, Holmes and Smith, 1997).

One of the most commonly identified concerns among managers of small Australian manufacturing and service firms is fear of losing valuable commercial information through the network. This leakage of information is recognized as a major challenge facing

business networks and is only really controlled via the trust and mutual respect held among network members. Many owner-managers also fear a loss of independence by entering into collaborative agreements or joint ventures. This attitude, plus the equally strong view that other firms might not to be trusted, or that suitable partners may not be available to network with and networking is risky, suggests a cultural mindset among Australian small firms that is anti-cooperative. Older, more established firms are likely to be more open to networking than younger, less established firms (Dean, Holmes and Smith, 1997).

Table 13: Significance of Constraints to Further Joint Initiatives and Alliances

1 = little or no problem 5 = critical constraint		Not important	Neutral	Important	Mean	Std.Dev
	N	%	%	%		
Potential to lose control of business advantage	70	28.6	25.7	45.7	3.14	1.333
Locating potential partners	70	31.4	27.1	41.4	3.14	1.277
Skills to set up and manage a partnership	70	30.0	27.1	42.8	3.11	1.210
Set up costs	69	36.2	18.8	44.9	3.04	1.387
Difficulty of managing overseas partnerships	69	37.7	21.7	40.5	2.97	1.514
Lack of industry cohesiveness	70	44.3	22.9	32.8	2.87	1.361

Within the WA ICT sector some of the key constraints to the formation of strategic network alliances appear to be concerns by firms that such collaboration may result in a loss of valuable intellectual property or competitive advantage. Around 46 percent of firms surveyed for this study indicated that they considered such potential loss of control an important factor in constraining their decision to cooperate. These findings are shown in Table 13, where it can also be seen that around 41 percent of firms indicated some difficulties in locating potential partners with which to network, and some 43 percent of firms appear constrained due to a lack of skills in how to establish such partnerships, financing set up costs or managing international alliances.

Financial Value of Alliances and Networks

The most critical test of the value of alliances and networks is their capacity to deliver financial benefits to the firms that participate in them. As shown in Table in 14, the majority of firms considered working with their lead customers or key suppliers to be the most valuable types of linkage from a financial perspective. Other types of alliance were viewed as being of much less importance, suggesting that the majority of firms perceived they were getting more from their production network than their resource network. Particularly noticeable is the low value placed on external technology transfer and joint research projects within the sector.

Table 14: Value of Various Linkages to the Financial Benefit of the Firm

1 = of little or no value 5 = extremely valuable	N	Considered valuable or extremely valuable	Mean	Std. Dev.
What is the financial value of …	N			
Working with lead customers	71	88.8%	4.24	0.978
Working with key suppliers	71	63.4%	3.51	1.263
Joint marketing and promotion	72	51.4%	3.21	1.288
Government sponsorship and support	72	48.6%	3.04	1.505
Joint product development	72	34.7%	2.86	1.325
Obtaining technology externally	71	26.8%	2.85	1.203
Joint research projects	72	26.3%	2.60	1.229
Joint distribution	72	30.6%	2.60	1.274
Joint production	72	13.9%	2.25	1.196

* As measured using pair-wise *t*-tests at the 0.05 level.

The Value of Alliances and Networks to Technology Transfer

A major benefit of inter-firm linkages is the ability of such alliances to allow the transfer of technology between firms in the network. The survey asked for firms to indicate whether or not their perceived access to sources of technology offered them any market advantages. The following question was asked:

> "Does your access to key technology to 'adopt' or buy, place you at an advantage or disadvantage relative to key competitors in pursuing market opportunities?"

In response to this question only 13 percent of firms felt that they were at a disadvantage relative to key competitors. Of the remainder, 44 percent considered they were on an equal footing with key competitors, and 44 percent felt that they had an advantage over competitors. These findings suggest that most firms were relatively satisfied with their access to technology. This may explain why so few firms considered obtaining technology from external sources to be important.

Sources of Technology Transfer

The survey also asked firms to indicate the general sources of their technology. The following question was used:

> "Of the key technologies that you 'adopt' or buy, please indicate what proportion is sourced: 1) within Western Australia; 2) elsewhere in Australia; 3) from overseas"

The responses to this question suggest that ICT firms in WA obtain their technology from local, national and international sources. Around 25 percent of technology was sourced from within WA, 35 percent from elsewhere in Australia and 37 percent from overseas.

Table 15: Importance of Various Sources of Key Technologies

1 = not important 5 = critically important		Not important	Neutral	Important	Mean	Std.Dev
Domestic sources:	N	%	%	%		
CSIRO	70	88.6	7.1	4.3	1.44	0.911
Universities, technical institutes	71	74.6	16.9	8.4	1.87	1.146
Parent or sister company	70	71.4	7.1	21.4	1.99	1.556
Other companies in your industry	71	36.6	25.4	38.0	2.99	1.368
Companies in other industries	71	60.3	23.9	15.5	2.18	1.211
Lead customers	70	35.7	25.7	38.6	2.83	1.362
Key suppliers	71	33.8	16.9	49.3	3.18	1.447
International sources:	N	%	%	%		
Universities, technical institutes	69	73.9	13.0	13.0	1.81	1.287
Parent or sister company	69	72.5	2.9	24.6	1.97	1.599
Other companies in your industry	69	53.6	17.4	28.9	2.38	1.426
Companies in other industries	69	72.5	13.0	14.4	1.83	1.175
Lead customers	69	60.9	18.8	20.2	2.12	1.388
Key suppliers	70	45.7	10.0	44.3	2.84	1.674

As shown in Table 15 the relative importance placed on various sources of technology by the ICT firms followed a consistent pattern whether or not it was sourced from local or international origins. Key suppliers – presumably for computer and related equipment – were viewed as important sources of technology with local suppliers rated as important by around half the sample. Customers were perceived to be of less importance, perhaps reflecting the nature of many firms as technology suppliers to such customers.

Most noticeable in Table 15 is the relatively low importance placed on universities, research agencies (e.g. CSIRO) and companies in other industries as sources of technology. These findings reflect the relatively low level of networking within the sector across the resource network layer.

The Value of Alliances and Networks to Securing Venture Financing

One of the main motivations for firms – particularly small technology firms – to seek collaborative alliances is to secure access to financial resources. The value of alliances and networks to the ICT firms in terms of accessing venture financing was examined in the survey. Firms were asked to comment on the advantages and value of such alliances to their financial and market performance. The following question was asked:

> "Does your access to financing place you at an advantage or disadvantage relative to key competitors in pursuing market opportunities?"

As shown in Table 16, only 8 percent of firms considered that access to debt financing (e.g. from a bank loan), placed them at an advantage to their key competitors. By comparison 23 percent expressed a more positive outlook in relation to equity financing (e.g. venture capital), but most were either negative or felt that their access to such financing offered no advantage.

Table 16: Relative Advantage or Disadvantage of Access to Finance

Does your access to financing place you at an advantage or disadvantage?	Debt financing	Equity financing
	%	%
Disadvantage relative to key competitors	40.8	43.9
Equal footing to key competitors	51.0	33.3
Advantage relative to key competitors	8.2	22.8

These findings suggest a somewhat pessimistic outlook for WA ICT firms in relation to securing venture financing with relatively high proportions considering themselves to be competitively disadvantaged. This was further reflected within a set of questions that examined the perceptions of WA as a place to do business.

Perceptions of WA as a Place to Do Business

An examination of how WA ICT firms view the state as a place to do business suggests that while there are many advantages perceived to be associated with locating a business in Perth, there are also many concerns. Table 17 shows the results of a series of questions asked within the survey to measure the perceptions of ICT firms toward WA. It can be seen that around half the sample considered that the cost of doing business within the state was low in comparison to other places.

Western Australia is frequently promoted as a place to do business due to its attractive climate and lifestyle. The majority of firms (60%) agreed that the WA lifestyle enhanced business. Another feature of WA is its relative proximity to major Asian markets. At least half the firms in the sample agreed that being on a similar time zone to Asia was convenient, however, it should be noted that many of the firms saw their key export markets in North America or Europe rather than Asia.

Table 17: WA as a place to do business – Perceptions of ICT firms

1 = Strongly Disagree 5 = Strongly Agree		Agree	Neutral	Disagree
	N	%	%	%
It is easy to access a workforce with the necessary skills and education	72	36.1	26.4	37.5
The cost of doing business is low in comparison to other places	71	52.1	22.5	25.4
Having a similar time zone to Asia is convenient	72	52.8	25.0	22.2
Geographic isolation is not a problem for our business	72	37.5	26.4	36.1
There is sufficient venture capital in WA to fund our future growth	70	14.3	25.7	60.0
It is easy to find high quality managerial staff	72	7.0	27.8	65.3
The lifestyle found in WA enhances our business	72	59.8	30.6	9.7
It is easy to access high quality research centres locally	67	16.4	35.8	47.8
Government support for local industry is strong	71	14.1	22.5	63.4

The geographic isolation of Perth from other major centres has often been viewed as a major weakness of locating a business in WA, however, opinion was evenly divided among firms about this with as many considering it was not a problem as did those who felt that it was. A similar view was held over the availability of skilled employees. Again, opinion was evenly divided among firms over whether it was easy to access people with

the necessary skills and education within WA to work in the ICT sector. Firms within the field of medical technologies were particularly negative about this issue.

Of concern are the findings that many firms considered WA to lack venture capital, quality management and government support. Around 60 percent of firms disagreed with the view that there was sufficient venture capital in WA to fund the future growth of their firm. Just over 63 percent expressed disagreement with the view that government support for local industry was strong, and only 7 percent agreed with the view that it was easy to find high quality managerial staff in the state. Finally, only 16 percent of firms agreed with the view that it was easy to access high quality research centres locally.

These findings, while only perceptions, present an image of WA within the minds of ICT firms as a place that offers an attractive lifestyle, relatively low costs and a convenient proximity to Asian markets. However, despite these comparative advantages, WA appears to lack several factors usually considered critical to the successful development of industry. Without adequate access to competent management, venture capital, high quality research centres and government support few industries, particularly in the high technology sector, can thrive. Whether such views are justified may be debated, but perception is often reality and these concerns suggest that many firms within the sector consider WA lacks such key elements.

Chapter 5

The Social Network Layer

The Process and Importance of Innovation

The third layer of linkages that are important is that of the *social network* (Holmlund and Tornroos, 1997). At this level the key participants are human actors, individuals who interact with each other via formal and informal social exchange arenas. In some cases these human actors maintain their relationships through the conventional supply chain interactions described in the production network layer. However, many such relationships can take place via professional associations or through even more informal exchange arenas (e.g. sporting or education links). This social network layer is important in the contribution it makes to the diffusion of ideas and tacit knowledge that is widely recognized as being the most valuable commodity in the innovation process (Augier and Vendelo, 1999).

The process of innovation adoption and diffusion within markets is widely recognized as following an "S" shaped curve where a few early adopters or *imitators* take up the innovation and if they are pleased with the idea it is transferred socially across to other imitators until it becomes widely adopted and eventually passes into maturity and decline (Sundbo, 1998). The diffusion process is a social one because it involves a two-way communication exchange between imitators with opinion leaders influencing others within their social circle to adopt or not to adopt. Such innovation can be *cumulative,* involving incremental additional steps to existing products and processes, or *substitutive,* involving the replacement of existing processes or products with new ones.

Contemporary research and development processes recognize the need for a *double loop-learning* model that involves a two-way communication flow between the firm developing the new technology and its customer(s) (Miller, 2001). Ideas, prototypes and discussions of appropriate systems architecture are exchanged within the network in an interactive way with the transfer of knowledge taking place between individuals within the various firms engaged in the process. This knowledge transfer process is possible without direct face-to-face human communication, but such communication – a process of *socialisation* – is considered essential to the transfer of valuable tacit knowledge (Nonaka and Takeuchi, 1995).

The Value of Networks to Small Firms

Although the formation of strategic alliances and networks can be a source of competitive advantage for firms of any size, they play a particularly valuable role for small firms. The small firm is faced with a shortage of resources (e.g. financial, managerial, physical) that will allow it to pursue the many opportunities identified by its management. In order to secure access to such resources the small firm needs to develop linkages and alliances of both a formal and informal nature through which it can acquire them. In addition to its relationships with customers and suppliers (via the production network layer), the small firm is also likely to benefit from alliances with financial institutions, sources of venture capital, employer associations, industry bodies, education and training institutions, professional advisors and government agencies (Jennings and Beaver, 1997).

Whether or not a small firm engages in cooperative behaviour is generally dependent on the mindset of its owner-manager(s) or executive management team. Key determinants driving small firm networking are social ties developed by the owner-manager, and the human communication flows that provide the owner with market intelligence and other valuable information (Donckels and Lambrecht, 1997).

As noted earlier, research into the networking behaviour of small firms in Australia suggests that few owner-managers fully understand either the importance or process of inter-firm collaboration, and most are fearful that such linkages will result in a loss of independence or leakage of valuable intellectual property (Dean, Holmes and Smith, 1997). However, those small firms that do seek to network are likely to do so for at three key reasons. The first is to open new market opportunities, perhaps by gaining access to new markets or new products, or widening the scale and scope of existing product-market combinations. A second motivation is to defend existing market positions, perhaps uniting with other firms to counter the threats of new market entrants or substitution threats. Finally, the firm may wish to use such alliances to develop its capabilities. It can secure knowledge, resources (e.g. human, physical and financial) and expertise through such collaboration (Jarrett, 1998).

Collaborative alliances among small firms are likely to be of two kinds. The first are production oriented and focus on joint product development, technology transfer or research and development programs. The second type is supportive and is likely to involve joint marketing, distribution and sales agreements, joint training programs and direct investment arrangements. Whether or not a small firm engages in such collaborative networks and alliances appears to depend on the propensity of the owner-manager(s) to collaborate, the opportunities that the owner has to engage in networks and whether such networks are viewed as socially or professionally desirable or prestigious. Factors likely to influence the level of inter-firm collaboration by small firms are the age and education levels of the owner-manager(s) and their social orientation (BarNir and Smith, 2002).

Social Networks as a Key Driver for Innovation

Because innovation diffusion is a sociological rather than an economic process the value of interpersonal communication via social networks becomes critically important. When people join together into homogenous social groupings (e.g. defined by common values, occupational, educational or socio-economic status) they tend to retain strong, durable relationships. However, a low level of innovation also frequently marks these otherwise strong ties. Within such homogenous groups the level of knowledge transfer among individuals is *isomorphic*, a situation in which all the actors begin to resemble each other leading to reduced innovation levels. It is only when individuals can form relationships with others outside their normal circle – via heterogeneous groupings – that they are exposed to new ideas and can access new knowledge. While the membership of such heterogenous groups is rarely durable, the benefits can be significant in terms of knowledge transfer. This relationship has been described as the '*strength of weak ties'* (Steward and Conway, 1996).

Networking behaviour among the managers and staff of firms can be both formal and informal. It can take place in recreational, social, professional and scientific exchanges. Research undertaken with high technology firms in the biotechnology, parallel computing and ceramics industries found an equal emphasis was placed on both formal and informal communications and relationships. Although research scientists acquired knowledge from formal sources (e.g. education programs, scientific journals, research studies), much was

also acquired from on-the-job experiences and social exchanges outside the workplace. This was particularly the case within the computing industry (Senker and Faulkner, 1996).

This study concluded with the following observations:

> "Firms make deliberate efforts to capture tacit knowledge. They do this by recruiting scientists and engineers who embody the required skills and tacit knowledge; by conducting in-house RD&D, and by promoting networking. By its very nature tacit knowledge is primarily transferred by example and practical experience. The *channels* through which tacit knowledge is obtained are thus primarily person-embodied rather than literature-based. Personal networks include internal links with other members of staff, with technical people in other companies (users, suppliers and competitors) and in public-sector research institutions. … we believe that flows of tacit knowledge are important not only for access to technical information to solve problems, but also for access to new knowledge generated through research. We suspect that much of the knowledge transferred through personal networks is tacit, but our evidence is suggestive in this regard. It may be, however, that the extent of tacit knowledge flows is higher than usual in the examples presented *because* we focused on newly emerging technologies" (Senker and Faulkner, 1996:93-94).

These findings highlight the importance of person-to-person communication in knowledge networks and the value of networks that are external to the firm. Managers seeking to enhance their firm's innovation need to not only recruit the people with the right skills, but also to encourage them to network beyond the firm.

Sourcing Information about New Technology and Innovations

With respect to the WA ICT sector sourcing ideas for new technologies and innovations appears to be undertaken via both formal and informal channels. As shown in Table 18, the Internet was rated as being an important source of information about new ideas and technologies by around 80 percent of firms. Most other sources of information were rated to be of modest importance to more or less the same degree.

These findings suggest that ICT firms in WA are securing most of their ideas for new innovation via web-based searching, rather than via formal literature or even research. This is likely to be a reflection of the type of information flow inherent within this industry. It suggests a relatively low priority may be placed on formal research and development within the ICT sector. However, it should be noted that informal meetings (e.g. personal networks) were considered important by just over half the firms surveyed.

It will be recalled from Chapter 3 that face-to-face communication between managers and staff from the ICT firms and their lead customers was considered important and that such interaction took place on a fairly regular basis (at least monthly contacts). This was confirmed by the interviews we conducted with the management of these firms. For example, one of the firms within the wireless technologies sub-sector acknowledged that the social network layer was probably the most critical level of networking. It was a major source of information; knowledge, technology and innovation transfer between the individual and firm actors within the industry. According the CEO of this firm a large number of managers and engineers from the company maintained contact with a personal social network using telephone, email and face-to-face contact. Senior managers in the firm allocated around 60 to 70 percent of their time to maintaining a social-professional network with a range of groups including financial institutions, venture capital sources, university researchers, government agencies and sources of technology. These networks

were local, national and international. Other staff, such as software engineers, also maintained similar social-professional networks.

Table 18: Importance of Various Sources of Information about New Technology and Ideas

1 = not important 5 = critically important		Not important	Neutral	Important	Mean	Std.Dev
	N	%	%	%		
Internet/web based searching	71	5.6	14.1	80.3	4.08	0.841
Formal literature (e.g. scientific journals)	71	16.9	23.9	59.2	3.52	1.026
Informal meetings (e.g. personal networks)	71	11.3	36.6	52.1	3.52	0.892
Formal research (e.g. field tests)	71	32.4	22.5	45.1	3.23	1.406
Formal meetings (e.g. conferences)	71	31.0	28.2	40.9	3.13	1.068
Informal literature (e.g. mass media)	71	32.4	39.4	28.2	2.96	1.101
Other sources	62	93.5	1.6	4.8	1.23	0.895

Within the defence technologies sub-sector another firm also highlighted the value of the social network layer. According to the CEO of this company there was a relatively high degree of informal contact between himself and defence force personnel involving golf games, membership of various associations and conferences. However, this CEO noted that such social networks were not as critical to winning new business as retaining existing business. Further, he explained that while 'old school ties' might be beneficial to the company when sourcing business within WA, they were of much less value in international markets. To develop export markets the company had been required to forge entirely new personal relationships with key people in foreign defence communities. It was his opinion that such social networking was an important function for all staff within the company, not just the senior managers. This was a similar pattern found within the majority of cases examined within the study.

Investment in Innovation and R&D

Firms were asked to indicate the proportion of their annual turnover that they spent on innovation and R&D. Responses ranged from nil expenditure to 100 percent of annual turnover! The average level of expenditure was 20 percent although half of all firms surveyed indicated that they spent less than 15 percent of annual turnover on R&D, with 75 percent spending less than 25 percent of annual turnover. An examination of the relationship between size of firm and export behaviour failed to find any significant association.

To put these findings into context an examination of the gross expenditure on R&D within Australia and other OECD countries within businesses during the 1990s found that the average was between 1.5 and 3 percent (AMC, 1994). Further, a research study of innovation within European industry found investment in R&D comprised about 20 percent of total expenditure among firms and comprised between 0.3 and 3 percent of total sales turnover (Evangelista, Sandven, Sirilli and Smith, 1998). Investment levels of 15 to 20 percent of gross turnover found among the WA ICT sector would appear to be good by comparison.

The Process of Innovation within WA ICT Firms

Just over half (56%) of the firms examined in this study indicated that they did not have a formal or well-defined process to carry ideas through to commercial implementation. However, of the 44 percent who said they possessed such a formal commercialisation process around 55 percent indicated that it was effective. As shown in Figure 3, while the majority of firms considered their formal commercialisation processes were effective or highly effective, there were a relatively large proportion of firms that were equivocal in their response.

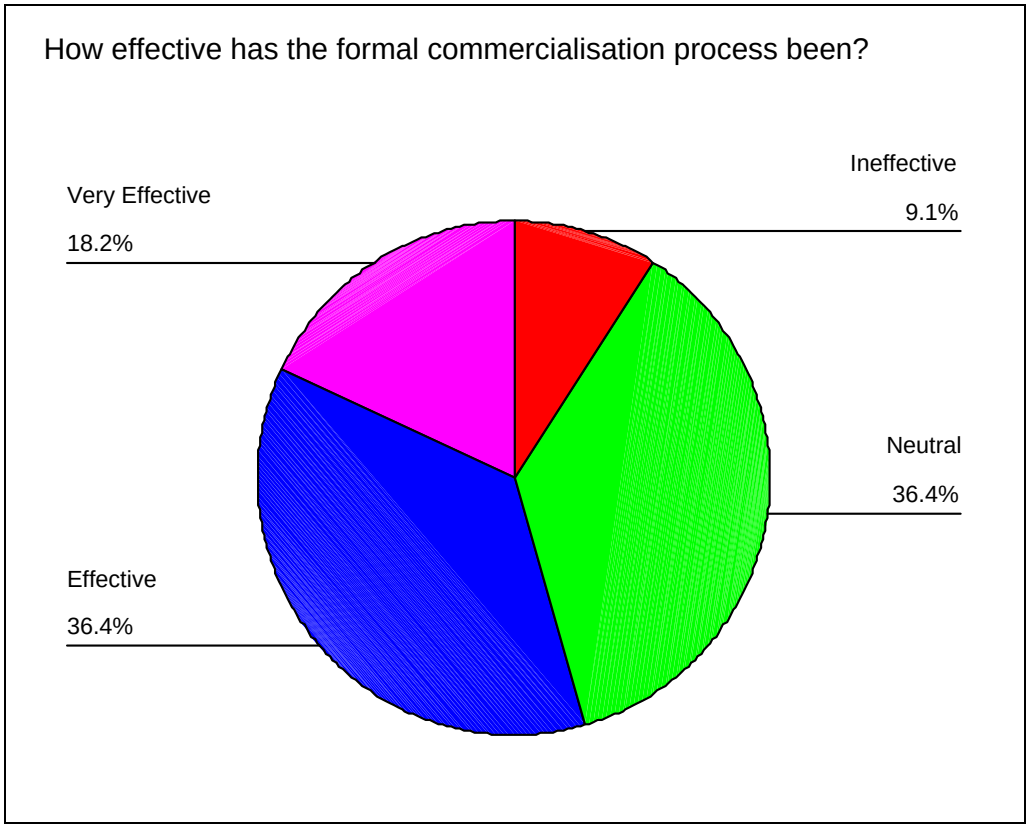

Figure 3: The Effectiveness of Formal Commercialisation Processes

In order to better understand the process of innovation within these firms a series of questions were used to identify the frequency with which different people within the firms became involved. As shown in Table 19 most firms indicated that their top management was frequently the most likely source of new ideas for innovations within the firm. The second most common sources were equally employees and customers. Formal product development teams or product champions were less common.

Table 19: Sources of Innovation within the Firm

1 = very infrequently 5 = very frequently		Very infrequently	Neutral	Very frequently	Mean	Std.Dev
	N	%	%	%		
Top management generates ideas for innovation	73	8.2	16.4	75.3	3.97	0.842
All employees generate ides for innovation	73	16.4	34.2	49.3	3.53	1.001
Customers are source of ideas for innovation	73	15.1	27.4	57.6	3.53	1.015
A creative genius is the source of innovation	73	45.2	17.8	37.0	2.88	1.509
Task force or team generate ideas for innovation	73	57.5	17.8	24.7	2.40	1.277
A product champion is source of innovation	73	41.1	20.5	38.4	2.89	1.400

This emphasis on the importance of senior management within the ICT firms as sources of new ideas may reflect a degree of sample response bias given that these same senior managers completed the survey. However, such findings are typical of the pattern of innovation within small firms where the owner-manager(s) or entrepreneurial management team is largely responsible for new ideas leading to products and market opportunities.

The Importance and Types of Innovation within WA ICT Firms

Innovation is a complex concept that has been appropriated in recent times to describe technological and scientific breakthroughs. However, innovation can involve quite a wide range of activities including the generation and implementation of new products and processes, or market and business systems configurations offering competitive advantage for those firms that successfully develop them (McIntyre, 1982). Innovation can be *incremental*, involving gradual changes to existing products or processes; *synthetic*, combining existing ideas into new ways of doing things; or *discontinuous*, involving the creation of radical new ideas or technological breakthroughs (Tushman and Nadler, 1986). Radical innovations involving disruptive technologies are generally rare in most industries. More common are incremental innovations that develop enhanced product or process technologies and systems providing superior levels of differentiation and added value.

Research into the application of innovation within small high-technology companies suggests that there may be four 'generic' types of firm: 1) *technology innovators* – those that introduce new generic technologies into existing markets; 2) *application innovators* – those that apply existing technology in established markets; 3) *market innovators* – those that develop new product concepts by combining them into existing markets; and 4) *paradigm innovators* – those that produce new product concepts with completely new technology (Autio and Lumme, 1998). This research found that application innovators and technology innovators were the oldest and largest among these four groups of firms. On the other hand, the largest potential for growth was found among market innovators and paradigm innovators. The trend in technology diffusion between these four generic types of firm was found to flow from the paradigm innovators to the technology innovators, then down to the application innovators. Market innovators ideas also flowed toward the application innovators.

Within the WA ICT sector the most significant levels of innovation appear to be occurring in the development of new products and services rather than processes, organizational structures or workplace practices. These findings are shown in Table 20.

Table 20: Type of Innovation in Key Areas within WA ICT Firms

1 = small and incremental 5 = large and significant		**Small and incremental**	**Neutral**	**Large and significant**	**Mean**	**Std.Dev**
How would you describe the type of innovation that occurs in your firm?	N	%	%	%		
New products or services	73	6.8	21.9	71.2	3.96	0.904
New processes	73	42.5	20.5	36.9	2.88	1.190
New organizational structures	73	67.1	27.4	5.5	2.10	0.930
New work place practices	73	74.0	17.8	8.2	2.10	0.960

Given the importance of innovation within the ICT sector, particularly in the development of new products and services, attention was given to the frequency and type of innovation undertaken. As shown in Table 21, the most frequent area of innovation activity with ICT firms is the development of new products and services. Less frequent innovations were felt to occur in other areas. Such findings are not surprising, particularly for small firms such as comprise the majority of companies in the WA ICT sector. It also suggests a relatively high level of innovation intensity among such firms where the development of a new product or service can provide a significant opportunity for a small firm.

Table 21: Frequency of Innovation in Key Areas within WA ICT Firms

1 = very infrequently 5 = very frequently		Very infrequently	Neutral	Very frequently	Mean	Std.Dev
How frequently does your company innovate in the following areas?	N	%	%	%		
New products or services	73	8.2	16.4	75.3	4.03	1.054
New processes	73	31.5	23.3	45.2	3.10	1.180
New organizational structures	73	57.5	23.3	19.1	2.37	1.137
New work place practices	73	56.2	26.0	17.8	2.48	0.988

The majority of firms surveyed considered that innovations in the development of new products or services were of the most importance to them. A total of 92 percent of firms indicated that they felt innovation programs seeking to develop new products or services were either important or highly important. Further, around 75 percent of firms considered that innovations leading to new products or services were likely to have either high or very high impact on the firm's performance.

In comparison to the development of new products and services the relative importance of other types of innovation was much less. For example, only 40 percent of firms considered innovation in new processes to be important and only 36 percent considered such process innovations to have a high impact on the firm's performance. The importance placed on innovation in organizational structures or workplace practices was significantly lower, with less than 12 percent of firms considering such types of innovation important. The overall impact of such innovations on the firm's performance was also considered to be high by fewer than 10 percent of firms.

An examination of the responses to these issues by firms of different sizes (using ANOVA tests), found a significant differences based on size. Micro-enterprises (e.g. firms with less than 5 employees) were found to place a much lower level of importance on product innovation than their larger counterparts did. Such firms also rated the impact of new product or service innovations significantly lower than the larger firms. A significant difference was also found among large firms (e.g. firms with over 200 employees). Larger firms were found to place significantly higher levels of importance on innovations in workplace practices.

That large firms should place a higher level of importance on innovations in workplace practices is unsurprising. As the scale and scope of an organization grows the need to find ways to maintain workforce productivity and coordinate the activities of large workforces increases. By comparison, small firms generally operate in tightly knit teams, coordinated closely by an entrepreneurial manager who provides the leadership to maintain productivity levels. The finding that smaller firms, particularly micro-enterprises, are less likely to see product innovations returning benefits to them is less easy to explain. Very small firms usually lack the resources to undertake high levels of continuous product or service development, and are more likely to focus on leveraging new market

opportunities with existing products. This may explain the lower level of importance placed on new product development by micro-enterprises.

When asked about the relative importance of a range of innovation activities to the ability of their firm to succeed in its industry, a similar pattern emerged. Table 22 shows the results of these questions. It can be seen that the development of new products or services was viewed as of most importance, with high levels of importance placed on after sales service, management and marketing issues.

Table 22: Importance of Innovation in key areas to firm's ability to succeed

1 = little or no importance 5 = Critically important		Unimportant	Neutral	Important	Mean	Std.Dev
How important are the following areas to your firm's ability to succeed in its industry?	N	%	%	%		
Unique / better products / services	72	-	8.3	91.7	4.67	0.628
After sales service	72	6.9	12.5	80.5	4.17	0.949
Management methods	72	5.6	13.9	80.6	4.01	0.942
Marketing and promotion	72	6.9	16.7	76.4	3.94	0.886
Labour productivity	72	19.4	18.1	62.5	3.56	1.149
Production processes	72	20.8	22.2	56.9	3.51	1.222
Distribution	72	23.6	27.8	48.6	3.33	1.138

Once again micro-enterprises were found to be significantly less likely than larger firms to view new product development as important, although these firms did rate such innovation as of high importance. Differences were also found among firms engaged in exporting when compared to firms that were not. Exporters were found to place a significantly higher importance rating (mean = 4.84) on the development of new products or services than non-exporters (mean = 4.47) did.[3]

The Success of Innovation within WA ICT Firms

With respect to the relative success of innovation activities within the ICT sector in WA the study found a high level of confidence in the success of product or service innovations, but much less confidence in other types of innovation. Table 23 shows the findings from the survey questions relating to this issue. It can be seen that the majority of firms felt that their product innovations were successful. However, the majority were uncertain about the merits of innovation activities in other areas, or considered such initiatives to be unsuccessful.

[3] As measured using a *t*-test of differences between the two means at a significance level of 0.05.

Table 23: Success of Innovation in Key Areas within WA ICT Firms

1 = highly unsuccessful 5 = highly successful		Unsuccessful	Neutral	Successful	Mean	Std.Dev
What has been the success in your firm of innovations in the following areas?	N	%	%	%		
New products or services	73	1.4	23.3	75.4	4.07	0.788
New processes	73	16.4	47.9	36.6	3.22	0.989
New organizational structures	73	32.9	50.7	16.5	2.70	0.953
New work place practices	73	31.5	53.4	15.1	2.75	0.954

Micro-enterprises were once again found to rate their success in developing new products and services as significantly lower than larger firms do. The findings suggest that as the size of the firm increases, the relative level of success placed on the development of new product innovations also grows. By contrast, no significant differences were found between firms of varying size in relation to the success in other types of innovation. No differences could be found between exporters and non-exporters in relation to these impressions of the success attributed to innovations.

Chapter 6

Applications, Devices, Infrastructure and Global Networks

The Wireless Technologies Sub-Sector

The wireless technologies sub-sector is one of the more complex segments within the ICT industry involving a variety of different actors engaged in software applications development, content developers and enablers, infrastructure providers, network operators, device and equipment manufacturers and the retailers. Since the first wireless telephony communications were commercialised in 1983, the wireless technologies industry has seen rapid and complex changes in the scope of its services, user growth, technological configurations and supply strategies.

The industry is characterised by rapid rates of technological innovation and high intellectual barriers to entry. It has been estimated that the take up rates of wireless technologies triples every 16 months, outpacing even computer power which doubles every 18 months. From 1983 to 2001 the number of components in mobile phones increased from 250 to 900 while at the same time mobile phone sizes reduced significantly. In 2001 it was estimated that there were around 640 million users of wireless products and services globally (Constance and Gower, 2001).

The Industrial Market System of the Wireless Technologies Sector

An industrial market system (IMS) refers to the overall structure of an industry or business system and comprises the various firms (actors) and the various activities that they perform, the resources required and the routines needed to make the business system work. A key point of focus are the relationships that exist between the various actors and how well suited they are to perform a given activity or function (Mathews, 2001).

The IMS for the wireless technologies sector appears to consist of at least seven key actors. First are the end-users, either individuals or organizations, with a need for wireless products and services. Second are the network operators, who design, build and operate voice and data mobile networks. Such operators include the large telecommunications firms such as Telstra or AT&T. Third are the application developers, such as Apple, SUN, Microsoft or Oracle, which provide software for equipment and devices. Fourth are the content developers and enablers that compile content into mobile ready formats so that applications can be easily packaged. Some of these firms include Apple airport, Yahoo, Jatayu, Apogee Networks and AOL. The fifth group of actors are the equipment and device manufacturers such as Nokia, Motorola, Siemens, Ericsson, Sanyo or Samsung. These firms provide a range of products including mobile telephones, palms, SIM pads and watch phones. A sixth group of actors are the infrastructure providers who design, manufacture and assemble switches, gateways and interfaces that allow mobile communications among subscribers. Many of the equipment and device manufacturers also perform functions in this area along with firms such as NEC and Panasonic. Finally, there are the retailers who sell and service the devices to the end users. Many of the same firms are found within each of these seven activity areas (Fine, 2001).

In analysing this industry sub-sector, eight case studies were undertaken with organizations engaged within different parts of the IMS. These were operating principally as application developers, infrastructure providers, device manufacturers and retailers. Due to reasons of confidentiality the eight case study firms examined in this study cannot be identified, however, their general profile can be outlined. All but two were successful commercial enterprises that had experienced good growth and were well recognized within their respective areas of activity. The other two were non-commercial organizations with a predominately R&D function. One of the firms (Wireless Case Study Firm 7) was headquartered overseas. Figure 4 illustrates the structure of the wireless technologies IMS, as well as the location of the case study firms examined in this study. It also shows the general nature of the relationship or interaction that takes place between these different actors.

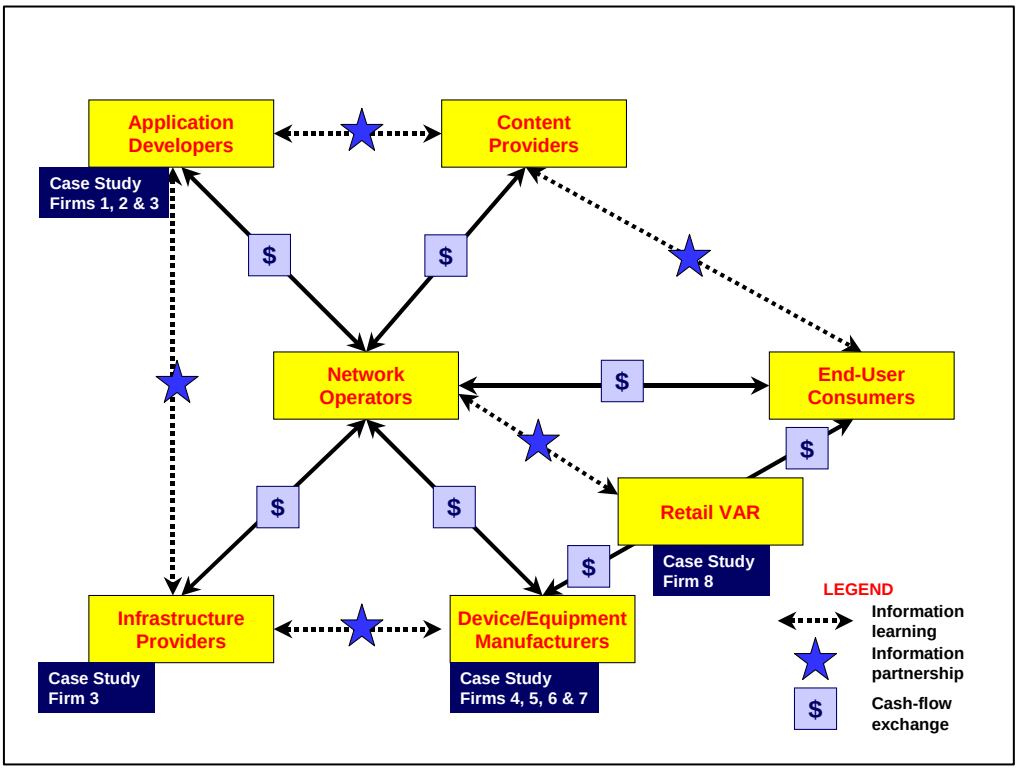

Figure 4: The Wireless Technologies Industrial Market System

The general nature of the linkages between these different actors is dependent on the type of activities they are undertaking and the characteristics of their products or services. For example, the network operators need the applications developers and content providers to enhance their services and target the needs of different end-users. The device and equipment manufacturers must ensure that their products are compatible with the systems produced by the infrastructure providers so that they can gain network access from the network operators. Compatibility must also exist between the applications and infrastructure systems. As a result of this need for compatibility and complementarity there is a dynamic interaction between various actors in the system involving both commercial exchanges and information partnerships aimed at maintaining the flow of ideas and innovations.

The Production Network Layer within the WA Wireless Technologies Sector

Within their production network layer the majority of the case study firms had formal agreements with suppliers and customers, mostly overseas. These firms were involved in design and testing (alpha and beta) of applications, devices or equipment. Two of the firms were application developers and four were device or equipment manufacturers. Hardware component design and manufacture has become something of a commodity process and is undertaken increasingly in low-cost countries, outside Australia. For the majority of these eight firms their major markets were overseas. These firms understood that the Australian market was too small and the domestic wireless technologies industry too limited for them not be actively engaged globally. Only by developing international linkages could these firms remain competitive and credible within their sector.

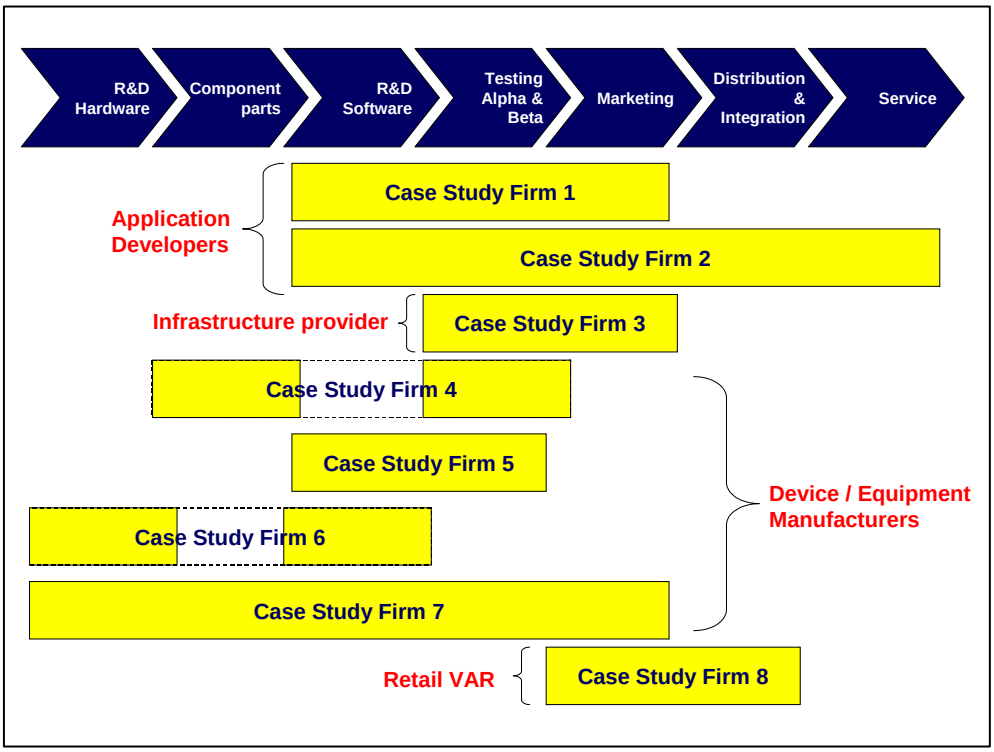

Figure 5: The Wireless Technologies Production Network Layer

The major activities or functions within the production network layer of the wireless technologies sector were hardware R&D, components manufacture, software R&D, alpha and beta testing, marketing, distribution and after sales service. None of the case study firms undertook all these activities, focusing instead of areas of specialization. As shown in Figure 5, each firm focuses on a particular range of activities although software R&D and testing was one of the most common activities.

Application Developers

The production network layers found among the application developers were similar in structure. For example, Wireless Case Study Firm 1 (WCSF 1) had a production network composed of a number of key R&D hardware and component suppliers, R&D software development partners, alpha and beta test sites and a global distribution and integration firm. This firm obtained hardware components from its key suppliers to provide the physical part of its products while it supplied the software component in collaboration with software partners. The testing of the entire system was undertaken using alpha and beta test sites in conjunction with its lead customers. Once the testing phase was completed, the firm distributed its product through a global distributor with which it had a close association. Most of these linkages were formal agreements and were with overseas organizations.

By comparison WCSF 2 also had a production network composed of a number of R&D hardware and component suppliers, R&D software partners, alpha and beta test sites and global distribution and integration firm. As with WCSF 1, the majority of these relationships were formal alliances with overseas organizations. WCSF 2 recognized that the WA market was too small and that it must develop strong linkages to international partners.

Infrastructure Provider

WCSF 3 was an infrastructure provider – albeit on a limited basis – and provided other ICT firms with a beta test site partner and potential lead customer. Within its production network, WCSF 3 provided valuable support for other WA-based wireless technology firms in its willingness to serve as a test bed and marketing channel.

Device or Equipment Manufacturers

Of the four firms engaged in the manufacture of devices and equipment only one case (WCSF 7) sought to capture a wide spectrum of the activities along the production network. WCSF 4 was a niche player headquartered in WA providing component design and testing services. Its customers were mainly located overseas, predominately in North America and Asia, and were generally large firms engaged in the manufacture of components. It was the function of WCSF 4 to provide the design services for future components that are then manufactured in Singapore and China.

WCSF 5 had a production network composed of specialized suppliers, and a small number of lead customers in established and emerging markets overseas. Each of these relationships was formal in nature. Because all the key suppliers and lead customers were located abroad, the senior managers of WCSF 5 spent much of their year travelling. They saw the Australian market as of significantly less importance than the international.

WCSF 6 was primarily a research organization focusing on hardware and software R&D that it sold or licensed out to other firms. Although headquartered in WA, the firm did not view the local market as particularly important and saw its main collaborative links as being with lead customers in the eastern states of Australia, or overseas. WCSF 6 was focused on research and new product design and development. The management of the firm viewed their relationships with lead customers as arms length in nature.

WCSF 7 was not a WA firm, but a Singapore-based subsidiary of a larger Asian-owned corporation headquartered in Hong Kong. It was included in this study as a comparison to

the WA companies. This firm undertook a wide range of activities in the design and development of wireless electronic devices. Its business network comprised key suppliers, lead customers and venture capital providers. This financial partnering was considered a major part of the firm's network. WCSF 7 had a production network composed of several hardware and components suppliers and operators, dealers and retailers. It operated as a vertically integrated organization undertaking most activities within the production network. Most of its alliances were formal in nature.

Retailer/Distributor

WCSF 8 was a major retailer/distributor of mobile, wireless and IT systems technologies in Australia and New Zealand. Its key suppliers provide all the required mobile equipment and accessories, and the company has several large lead customers comprising the major telecommunications network operators. The production network of WCSF 8 was composed of a large number of mobile equipment and accessories suppliers and a smaller number of very large customers. Most of its alliances with both suppliers and customers were formal in nature based on legal contracts.

The Resource Network Layer within the WA Wireless Technologies Sector

A common theme found among these case study firms was their recognition of the importance of their resources network to the development of their business. Critical to the success of their products and services was the continuous learning and transfer of knowledge and technology to enhance their innovation process. Linkages included participation in industry associations and trade shows, as well as connections to government agencies, universities and financial institutions. A general perception among these firms was that their resource network, while valuable, was not sufficiently broad. Most expressed frustration at having insufficient time to develop this network, and the limitations placed on securing overseas linkages due to the geographic isolation of Perth.

One of the most important linkages for these firms was securing access to technology and knowledge resources. Most of the firms had established partnerships with other organizations to undertake R&D in software and hardware. These links offered an opportunity to secure access to technologies and intellectual property. However, there was a view that such linkages were limited within WA with few firms having any strong alliances with local universities. Further, there were no plans to change this situation.

Access to financial resources – particularly venture capital – was another area identified by the firms as of critical importance. Several of the firms sourced venture capital from overseas, primarily from London, New York and Hong Kong. It was noted that these cities were felt to be more mature markets for venture capital capable of supplying greater sums of money. Most of the firms complained of a lack of venture capital finance in Australia and especially in WA. According to many of the managers we interviewed, the local venture capital providers held divergent goals and outlooks to that of the company's seeking the funding. One firm expressed frustration at being unsure of how to gain access to experienced financiers in WA. They complained of having been 'taken for a ride' by local WA-based venture capital providers during the early years of the firm's history.

Most of the firms had formal linkages with government agencies, primarily for assistance, guidance and support. However, their linkages did not extend to government funding due to the compliance costs involved in applying for what were seen as oversubscribed grants. Some firms believed that the government (both state and federal) did not communicate adequately with small businesses and offered little real support. Another common theme

was that the government kept changing the structure of its departments and thereby shifting the points of contact, making it more difficult to establish long-term relationships.

Few of the case study firms had linkages to local universities on either of formal or informal basis. There were few cooperative arrangements in the fields of hardware or software R&D. The main linkages that did exist were through the recruitment of local graduates and other technical staff. It was felt that local university graduates were of high quality, but could be employed for relatively low wages when compared to recruiting staff from overseas. These staff recruitment linkages were very informal. The local ICT engineering community in WA is also small with strong inter-personal networks. Most firms recruited their staff through word-of-mouth. The majority of firms expressed a desire to strengthen their ties with local universities so as to improve their access to quality graduates, and to collaborate over projects dealing with 'hard' problems during the early stages of development

Resource Network Layer of Wireless Case Study Firm 1

To illustrate the operation of the resource network layer, the example of the WCSF 1 can be shown. The resource network of WCSF 1 is quite large in both scale and scope. Access to technology and knowledge is secured via software partners, trade shows, industry groups, Bluetooth groups, beta test sites, telecommunications network operators and even with competitor firms. WCSF 1 was engaged in establishing a users group involving some of its competitors so that they could learn from each other and cooperate for a 'win-win' scenario. However, there were no linkages with any of the local WA universities.

WCSF 1 viewed its links to venture financing as critical to its continued growth. Several venture capital firms had invested in the company and held positions on its board. The firm had secured its financing from the United Kingdom and United States, and had established offices in London and New York to ensure that it could maintain adequate communication with its partners.

WCSF 1 had no formal linkages to government agencies and had sought no financial assistance from these sources. Informal links did exist with local and international universities to secure both technical specialists and management expertise. Such links were based on the experience of the senior managers of WCSF 1 who tended to return to the universities where they had obtained their qualifications to seek future graduate employees.

Resource Network Layer of Wireless Case Study Firm 4

The resource network of the device and equipment manufacturer/service provider case WCSF 4 was focused less on securing venture capital, and more on sourcing strategic management expertise. WCSF 4 recognized that it needed to enhance its strategic management competencies. It had forged a partnership with one of the leading international financial and management consultancies; however, the cost of this relationship restricted the amount of time that could be devoted to it.

Within the local Perth community there was a strong informal network between ICT engineers that the senior management of WCSF 4 could leverage to obtain advice and feedback in relation to financial and strategic planning initiatives. These linkages were generally based on personal relationships.

WCSF 4 expressed a desire to strength its ties with local WA universities so as to improve its access to quality graduates and possibly collaborate in joint research projects. Its innovation process involved intensive interaction with component manufacturers an this had widened its links within both the Australian and United States microelectronics industries. Two particular organizations that WCSF 4 held within its resource network were the Australian Microelectronics Network (a government-led organic national body attempting to foster enhanced collaboration within the industry), and the Australian Microelectronics Centre (a Queensland-based organization that aims to build an industry cluster).

WCSF 4 received almost no government funding and its senior managers suggested that the compliance burden associated with the application process for what where heavily oversubscribed grants outweighed any benefits that might flow from such schemes. The managers considered that the government did not communicate adequately with small firms such as WCSF 4 and offered relatively little effective support. It was only once a firm grew large enough to 'register on the government's radar' that they began to receive attention. This was a criticism levelled at both state and federal governments. The managers were seeking to make contact with federal government representatives and express their concerns over such matters; however, this lobbying effort was time consuming. WCSF 4 considered that constant changes in government policies were disruptive and created unnecessary compliance costs. For example, one of the senior managers from the company had been required to devote four weeks out of the previous year dealing with complex taxation issues and securing a ruling from the Australian Taxation Office.

The Social Network Layer within the WA Wireless Technologies Sector

Most of the case study firms had comprehensive social networks usually based around their senior executives and key technical staff. It was widely felt among these firms that the social network layer was the most critical because everyone in the company was involved in social networks. Such interpersonal contacts were recognized as valuable channels of information and knowledge flow, as well as sources of technology transfer and innovation. Many of the engineers and managers within these firms maintained contact with their social networks via email and telephone, as well as face-to-face contact at social occasions and trade shows.

It was estimated that around 60 to 70 percent of managers time was taken up maintaining their social networks. Engineers in the same process spent a slightly less but still significant amount of time. Many managers travelled widely to maintain such contacts, particularly overseas. Engineering and technical staff was also frequently involved in such visits, or with the installation of products. Such direct contact with customers was viewed as beneficial to the firm's ability to properly service its contracts and understand the needs of the market. An important observation of the social networking within these firms was that most of these linkages were with people located overseas rather than in WA.

Social Network Layer of Wireless Case Study Firm 2

The social network maintained by WCSF 2 was quite complex. The CEO of the company considered this a critical network for enhancing the flow of ideas and information. All managers and engineers maintained contact with their social network contacts using a combination of email, telephone and face-to-face visits. The CEO also wrote personal letters to customers, suppliers and other important network partners to facilitate and strengthen these relationships.

Frequent overseas travel by managers allowed personal contact to be maintained with important contacts and seek new alliances, especially new customers. Because WCSF 2 had a worldwide market such international travel was essential despite the time and cost involved. While the senior managers and sales staff were regularly visiting customers, the firm maintained a policy of having engineering staff become personally involved in the installation of products and communicating directly with customers.

Social Network Layer of Case Study Firm 4

The management of WCSF 4 viewed its social network primarily as a source of obtaining engineering and specialist technical staff. There was a desire to increase its linkages to the local universities so as to identify and eventually recruit graduate engineers. It had already established such networks with the University of Western Australia due to the fact that most of their staff had been educated at that institution.

CSF 4 recognized that they maintained only limited contact with other small wireless technology firms within the sector. This was attributed to the nature of the Australian industry. A lack of communication between industry participants was cited as a major area of weakness for the wireless technologies sector both locally and nationally.

General Assessment of Networks within the WA Wireless Technologies Sector

In general the wireless technologies sector in WA is in a position to maintain successful network relationships, however most are small, mostly independent firms that are focused primarily on their production networks. There is an absence within the state of large firms that can serve as a focal point (focal firms) for concentrating the efforts of other network actors. Most firms are either in the early stages of new product development, or service niche areas within larger global industry supply chains. It is difficult for such small firms to secure adequate recognition within global markets and they can be easily overstretched if market or product development opportunities present themselves.

The firms examined in this industry sub-sector appeared to be conscious of the importance of networking but expressed anxieties over loss of competitive advantage with seeking to manage such strategic alliances. All possessed stories of 'burnt Australian companies' that had become victims of alliances gone badly. However, such concerns did not appear to be a major disincentive to their willingness to create new alliances.

One of the main areas of concern among firms was their tendency to 'overspecialise' in the sense that technical staff occupied senior management positions and thereby lacked the commercialisation expertise to manage world-class companies. This was most recognized in the area of strategic management and planning competencies within the firms, and their ability to attract venture capital. Both WCSF 1 and WCSF 2 possessed CEOs with sound business education and experience. These firms appeared to have a better approach to commercialisation and business development.

While these firms were able to demonstrate world best practice in the fields of product design and development, they lacked a similar capacity in marketing and management expertise. For example, the CEO of WCSF 4 commented that Australian firms were particularly ineffective in early stage marketing, at 'selling themselves' – both locally and internationally – and in developing and exploiting networks. He suggested that this was due to such factors as Australia's 'culture of mistrust', a lack of local competition, commercialisation expertise, quality lead user markets, and world-class suppliers.

There was a noticeable absence within the case study firms of 'tight' alliance relationships (e.g. long-term partnerships based on trust and involving intensive and frequent exchanges of information and ideas). If the international linkages of these firms are removed from the analysis the few production network relationships that do exist at the local level are generally weak and are focused primarily on beta testing. Most of the firms are engaged in R&D activities and are highly specialized into discrete niches within the IMS. Such specialization appears to be partially responsible for the low level of interaction between firms within the production network at the local level. There are few opportunities for these firms to become suppliers or customers to each other.

The wireless technologies sub-sector in WA also has relatively weak linkages within the resource network layer. It is largely the state government that provides any degree of local focal point for the facilitation of such relationships. While some linkages do exist between these firms and sources of financial investment, the general picture that emerges is one of only weak links and a need for local firms to seek venture capital offshore. A similar pattern exists in the relationship between these firms and the universities. While some collaborative R&D is occurring via Cooperative Research Centres, few firms possessed any significant research links, although most saw merit in doing so. Universities were seen as primarily sources of new human capital.

In conclusion, the wireless technologies sector in WA demonstrates no evidence of comprising an industry cluster. While there are several firms geographically proximate within Perth these same firms do not demonstrate significant levels of either cooperation or competition between themselves. Many perform similar activities within the production network (primarily R&D), but are so highly specialized that they service different market segments. The local production network within WA is not robust and is actually a small part of much larger international industrial market systems. Cooperation among the firms at the local level is limited and there are few examples to be found of co-dependence or mutuality. The disappearance of any one firm would appear to have little effect on any of the others. Further, at the resource network layer firms are largely unconnected to other related industries at the local level, including financial and research agencies. While the quality of the local universities in acknowledged they generally lack sufficient concentration of activity to provide the impetus to innovation that is required by the industry sector. Finally, many in the sector view government policy as unsupportive. Apart from R&D grants (which tend to involve significant compliance costs), there is a perceived lack of tax concessions that would place Australian firms on an equal par with competitors overseas.

Chapter 7

Exploration, Extraction and Processing

The Mining Software Sub-Sector

The mining and resources sector in Western Australia accounts for around 20 percent of the state's export income and generated over $6.9 billion in state revenues during the 1990s (www.mineralswa.asn.au). Oil and gas generate the largest share of these revenues, followed in turn by iron ore and gold. The state's mining industry has applied technology throughout its history to achieve higher levels of productivity and develop world best-practice and international competitiveness. For example, the gold mining sector has drawn people and ideas from local and international sources, particularly South Africa and North America. Within the iron ore industry WA is recognized as one of the world's major centres for excellence in mining technology and expertise.

There are over 200 exploration and extraction companies based in WA. This includes the top 20 largest mining companies with market capitalisation in excess of over $500 million, multiple mine sites and many smaller firms. The larger mining companies tend to have exploration, mining/extraction and milling/processing functions integrated into their operations. Smaller firms are more likely to specialise in exploration or mining by using other companies existing resources for milling. Within the larger firms the organizational structure tends to be silo-like, with the three functions of exploration, extraction and processing separated by formal command structures while extensive informal linkages exist between these at the lower levels providing there is some geographic proximity between the work functions.

The Industrial Market System of the Mining Software Sector

Within the mining software sub-sector of the WA ICT industry there appears to be two primary segments. The first is that associated with the exploration and extraction phases of the mining and resources industry. This is focused on the design and development of application software. The second is associated with the milling and processing activities and involves both software and hardware.

Exploration and Extraction ICT Segment

The segment associated with provision of application software and hardware for the exploration and extraction phases focuses on producing mainly off-the-shelf software to support the exploration and mine planning activities of mining companies. Globally there are an estimated 15 major suppliers of such software, with WA-based firms holding a strong, perhaps even dominant, position. Most mining companies use separate software for exploration and extraction, although there is a trend toward a merger of these two application environments. All major firms in the segment have sought to extend their market reach by developing export opportunities, and have opened offices in some of the leading mining centres around the world. There are concerns that the global market is becoming saturated.

Milling and Processing ICT Segment

The milling and processing segment is distinctive in that it supplies custom made solutions to customers, with each mine site having unique systems and requirements. The segment also has strict performance requirements regarding reliability. Given the nature of minerals milling and processing the cost of stopping production due to computer breakdown is significant. Within WA there are several firms that have a significant presence in the market. Many of these firms also export.

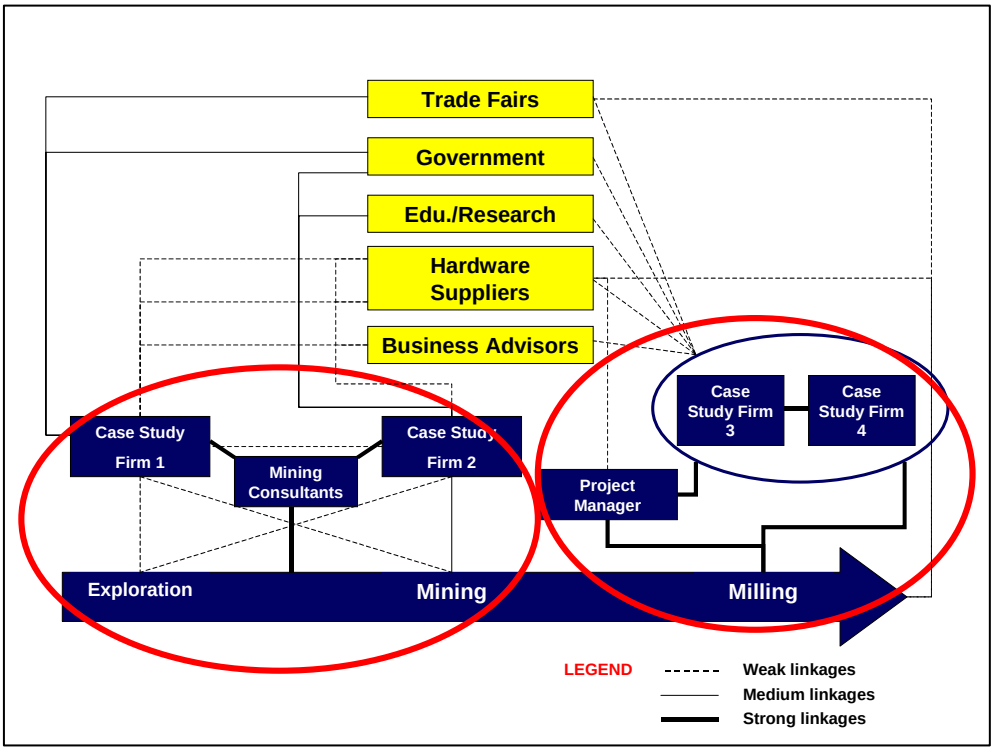

Figure 6: The WA Mining Software Industrial Market System

Figure 6 shows the IMS for the WA mining software sector as well as the location of the case study firms examined for this study. Bounded by the circles are the two key segments (e.g. exploration, mining/extraction, and milling). In addition to the ICT firms other actors include mining consultants and project managers, as well as government agencies, educational and research institutions, hardware suppliers and business advisors. Mining consultants typically use most of the software applications developed for use in the industry, and advise and supply the most appropriate software when commissioned to do so. The project managers (e.g. Fluor Daniels, SKM) are contracted to construct and install new minerals processing plants. They will either sub-contract or supply the appropriate ICT services for their clients. Hardware suppliers to the exploration and mining segment are usually standard personal computer systems. However, the milling segment requires more specialized hardware that is often supplied by software producers as a complete package if required. Firms such as Siemens and General Electric are typical suppliers to this segment.

The Production Network Layer within the WA Mining Software Sector

A total of eight case study firms were examined within the WA mining software sector. Of these firms, five were directly involved in the ICT industry; the others were mining consultants or project managers. Interviews were also conducted with customers and suppliers, principally major engineering construction companies and mining companies based in Perth. These firms will be referred to as Mining Case Study Firms (MCSF).

The production network within the sector is different for the two key segments. For example, within the exploration and mining/extraction segment involves few suppliers and usually a few major customers. Although the degree of product differentiation between software products within the segment is low, a degree of protection is afforded due to the high switching costs associated with a customer deciding to adopt a new application. Once a customer has adopted a product and trained its staff it is unlikely to make a switch as this will not only incur a direct cost in time and training, but a potential loss of productivity as employees become familiar with the new systems. An important success factor for ICT firms in this segment is having their software accepted by a sufficiently large enough customer base to be viewed as an industry standard. This is a similar situation to business software applications such as word processing and spreadsheet programs.

By comparison, the milling and processing segment involves a greater level of balance in the power relationship between the supplier and customer due to the highly specialized nature of the software applications. New entrants seeking access into the segment face the challenge of establishing appropriate industry contacts, and developing the required expertise to provide the products required. The stakes are somewhat higher in this segment due to the need for low failure rates. As a result, reputation of the firm is critical to securing contracts and reliability and service support are essential criteria.

Contact between the ICT firm and the customer is usually close and frequent during the design and development of a new product for applications in the milling/processing segment. The development and final adjustment typically happens on-site or at the mine site. It is therefore important for firms to be located in close physical proximity to customers. By comparison, the firms operating in the exploration and mining/extraction segment (e.g. MCSF 1 and MCSF 2) did not have the same need for physical proximity. These firms provided a more off-the-shelf product and tended to make greater use of telephone, email and mail as media for communication with customers.

The firms located within the exploration and mining/extraction segment considered participation in trade fairs of valuable. However, this was not the view of the firms operating in the milling/processing segment. This difference between the two segments is explained in terms of the characteristics of their respective products. The application software used in the exploration, mining/extraction segment is somewhat generic and once sold to customers requires relatively little follow up. Trade fairs offer the firms from this segment an opportunity to meet existing customers and examine the latest trends in competitor products. For the firms in the milling/processing segment the highly customised nature of their products makes trade fairs of less value. These firms are in close and frequent contact with customers.

Competition between firms in the exploration and mining/extraction segment is very high with strong competition for the same customers. As a result there is little collaboration taking place between firms from this segment and limited exchange of staff or information. The level of market saturation within this segment is also high and firms have begun to increase the intensity of their competition with each other moving across from exploration

software into mining/extraction software and vice versa. The need for continued growth has meant that these firms are focusing upon international markets.

Within the milling/processing segment competition is less intense due to the greater differentiation between firms. While firms in this segment remain rivals, there is more willingness to collaborate, usually in the form of information and even staff exchanges. Competition within the segment is viewed as less important than maintaining the overall competitiveness of the segment as a means of keeping the barriers to entry high so as to block out potential new market entrants. The threat of new entrants has been a major driver to collaborative behaviour among these firms.

Growth within the milling/processing segment has been via the development of new product/market combinations. The firms in this segment were found to have used their knowledge of process technology in the minerals sector, to diversity their products into other industries that have a similar need for such applications. However, although these firms do not ignore international market opportunities, they were less focused on exporting than their counterparts in the exploration, mining/extraction segment.

As a final comment on the production network within the mining software sector it should be noted that firms operating at either end of the production layer appeared to have little understanding of how the entire system operates. Managers from firms at one end of the continuum expressed little understanding of the firms operating at the other. When asked directly MCSF 1 management indicated that they had little knowledge of the staff or activities within MCSF 3 or MCSF 4. A similar response was elicited from the management of these latter firms. The managers from MCSF 3 and MCSF 4 could only name MCSF 1 and MCSF 2 and identify their leading products. They could not provide the names of any individuals working in these firms or much about their activities.

The Resource Network Layer within the WA Mining Software Sector

The technology used within the mining software sector changes significantly as it moves along the production network layer. For example, compared to the milling/processing segment, the software used in the exploration area is more or less a standardised product that can be packaged and sold in an almost off-the-shelf manner. As noted above, the software used in the milling/processing segment is highly customised. Lying somewhere in between are the software products used in the mining/extraction area, although these tend to be closer to the exploration area in their characteristics. These product-market attributes have a direct impact on the behaviour of these firms within the resource network layer.

Due to the highly customised nature of the software used in milling it is somewhat rare for firms in this segment to hire graduates. For example, MCSF 3 explained that they had a preference to seek employees with existing skills and experience rather than commit time and resources to the training, monitoring and development of novice engineers. It should be remembered that key success factors for firms in this segment were reliability and zero failure rates. Given the limited pool of local engineers with the necessary experience, it was unsurprising to find that there was a flow of people between the various firms located within this segment. By contrast, the exploration, mining/extraction segment was more open to the hiring of new graduates. Both MCSF 1 and MCSF 2 recruited graduate engineers on a regular basis for their product development departments. The higher levels of competition among these firms reduced the flow of people between them.

Innovation within the exploration and mining/extraction segment was found to be heavily reliant on internal research and development activity. However, in the milling/processing segment innovation flows more through social networks and the transfer of tacit knowledge as employees transferred from one firm to the next. There was little evidence found of close partnering with universities over research and development. Most of the firms provided their software products to the local WA universities, particularly for training future mining engineers, but there was minimal cooperative research taking place between these institutions and the firms. Innovation within the sector was focused principally on the development of new products. Collaboration was therefore mainly with customers in order to improve products and tailor them to the needs of specific customers and thereby retain market position.

Interviews with managers from within these firms indicated a general perception that government agencies lacked interest in their industry and did not interact with them or offer much assistance. Within the mining software sector in WA the common belief appeared to be that government officials only became involved in times of emergency, crisis or when seeking to obtain research data for industry level studies. Further, the results of such surveys rarely appeared to be fed back to industry participants. Managers also appeared unaware of the industry-level contact point or persons within government to whom they might go to seek assistance. It was felt that government agencies provided little information on the various services that might be available to firms.

The Social Network Layer within the WA Mining Software Sector

Personal interaction between individuals within the mining software sector takes place on many levels but can be examined in the context of the transfer of knowledge and ideas that mostly occurs within the production network. A major difference was observed between the behaviour of firms within the exploration, mining segment and the milling segment. In the exploration and mining-extraction segment firms were generally highly competitive and there was little trust shown among members. Due to these conditions it was typical for individuals within the various firms to avoid substantial social interaction. Interpersonal contacts with customers were sometimes used to elicit information on rival firms and target potential business opportunities to win market share from competitors. This contrasted with the milling-processing segment in which firms frequently swapped ideas and transferred knowledge through the sharing of employees to provide labour and expertise to handle large projects.

Tacit knowledge transfer within the milling-processing segment appears to occur frequently via interpersonal communication. Most firms in this segment rely heavily on recruiting employees with previous work experience within the industry. These people tend to migrate across the segment from firm to firm, following work as projects arise. This behaviour serves to facilitate the flow of ideas throughout the segment. However, this knowledge transfer is largely uncoordinated and unrecorded. Unlike the milling segment, firms in the exploration, mining-extraction segment generally do not refer their customers to other firms in the sector if they cannot provide the appropriate solutions to a particular problem.

General Assessment of Networks within the WA Mining Software Sector

A comparison of the firms examined within the mining software sector suggests that most were founded in Perth and have been in existence for less than 20 years. In many cases the original founders of the company still play an important role in the daily management. These firms are generally small in size with less than 20 employees, but have a positive

outlook in relation to future growth. When these firms expand into new markets outside WA, their development staff remains in Perth. Most seek to retain a WA-base due to the lower cost of living and operating businesses, the life-style and for historical reasons. Perth is viewed as one of the leading mining centres in the world and Australian mining software technology is generally considered to be world-class.

Despite the strengths inherent within the WA mining software sector there is little evidence of an industrial cluster or even a cohesive network. The sector has many advantages upon which to build. It is geographically proximate to some of the world's most efficient and technologically advanced mining and resources companies. Further, the mining and resources sector within WA has succeeded in forming a cluster comprising a large network of related and supporting industries, of which this sub-sector is an example. The mining software sector benefits from close contact with lead customers and a concentration within Perth of expertise in key areas of specialization.

Exploration and Mining-Extraction Segment

A major barrier to enhanced collaboration within the exploration and mining-extraction segment is an apparent lack of trust between firms. While competition is understandable in this segment some opportunities are being lost due to the lack of inter-firm interaction. Independent intermediaries who could serve to stimulate information flows with a view to enhancing innovation might facilitate informal exchanges between firms within this segment. Such intermediaries have been tried in the USA, serving as human bridges between firms and alleviating the risk of breaches of confidentiality by managers. Such intermediaries tend to be retired former senior managers or technical specialists with the ability to engender trust from various members in the network (Wolpert, 2002).

Securing cooperation among otherwise fierce rivals is likely to be difficult, however, given the saturated nature of the WA mining software market in this segment, a degree of collaboration in the pursuit of export markets may be a useful starting point. Here government agencies may be able to play a role, facilitating export opportunities and assisting firms to participate in international trade fairs in selected target markets.

Milling-Processing Segment

Future development within the sector is likely to benefit from enhanced collaboration between firms. Within the milling-processing segment there is scope for a greater level of formalisation of the existing relationships between firms. There is scope for more formalisation in the relationships between ICT firms and the project managers and other consulting firms who may compliment their production activities. Closer collaboration would also have the potential to alleviate the occasional shortages of experienced employees during peak periods. This inability of local WA firms to service such demand often results in work being contracted to interstate firms.

There is also a high demand within the segment for the employment of sub-contractors to fill in gaps within the ICT firm's areas of expertise. These sub-contractors generally provide services associated with the installation of equipment and electrical wiring, mechanical structures or fibre optic cabling during construction of plants. Better coordination of the pooling of such labour, perhaps via a specialized employment network, could facilitate the timely recruitment of local sub-contractors and further stimulate business development within the mining ICT industry.

The segment also uses common tools and products, but problems appear to exist in the supply and distribution network. For example, the most widely used component of mining software development and support is the computer. Current industry practice is based on individual firm-level procurement systems. Given the small size of many firms this is potentially inefficient. Collaboration among firms to procure common-use equipment and collectively leverage purchasing power may enhance purchasing power within the segment.

A common concern among all firms – regardless of which segment they belonged to – was a fear of the threat posed by computer hackers and software viruses. Most firms spent a large amount of money and staff time protecting software. One point of potential future collaboration may be to unite their efforts in order to provide for an effective solution to this problem. Government support in such an endeavour would also be useful, either through direct funding, infrastructure provision or encouraging the development of specialist companies able to develop effective software security systems.

Chapter 8

Submarines, SAS and Intelligence Systems

The Defence Technologies Sub-Sector

The defence technologies sub-sector has received relatively little public recognition within the WA ICT- sector and is difficult to research due to the sensitive nature of many of its activities. This sector is unique in that it services the needs of only one domestic customer – the Australian Department of Defence. The result of this monopsony is that the sector has industry dynamics unlike its counterparts in other areas. Much of the focus of the defence technologies sector is concentrated on providing customised software engineering solutions for a wide variety of military applications ranging from command and control systems to underwater sonar capabilities.

The Australian defence market is estimated at around $12 billion (compared to the US market of $730 billion), but recent changes in the world security environment have seen the Commonwealth Government announce an increase in defence spending by three percent per annum in real terms over the next decade, an increase expected to total $23.5 billion in real terms (Robert Hill, ANZIDECC, 2002). Expenditure on defence software products has traditionally been low, however, the advent of smart weapons systems has significantly increased the value of computer systems, particularly software, within the modern military.

The Industrial Market System of the Defence Technologies Sector

Globally the defence industry is comprised of a few very large corporations and a large number of small firms that usually supply to the large ones. Within the WA defence technologies sector around two-thirds of firms employ less than 20 staff. Software engineering requires few input factors other than human capital. The labour market for qualified software engineers in WA is generally good, although the occasional shortage of key personnel can be a critical inhibiting factor for firms.

The presence within WA of major components of the Royal Australian Navy (RAN), particularly the Collins Class submarines and ANZAC frigates, has provided a major impetus to the defence technologies sector in the state. Further, the strong collaboration between the RAN and US Navy (USN) offers additional opportunities. Agreements allowing the docking and even minor refitting of USN warships at the RAN Fleet Base West at Garden Island are examples of this. WA is also home to the Special Air Service Regiment (SASR) and the Royal Australian Air Force (RAAF) base Pearce, which is home to RAAF and Singaporean flying training squadrons.

The Defence Material Organization

Within the local market a key actor is the Defence Material Organization (DMO), which maintains a regional office (DMORO) in Perth. This acts as a liaison point between the Australian Defence Force (ADF) and private sector suppliers. The key task of the DMO is

to facilitate the acquisition of capital equipment and systems required by the ADF, and to seek local sourcing of such equipment where possible.

The DMORO offers a potential conduit for local defence industry suppliers to access the military. In 1998 the DMORO went through a substantial restructure with staff reductions from an initial 30 employees down to zero. Criticism of the effective closure of the local DMO office in WA and subsequent lobbying resulted in it reopening in 2000 with a staff of three. The DMORO serves as a facilitator or broker seeking to enhance the procurement process for the ADF.

Export Restrictions

Given the small size of the local defence market, it is unsurprising that many firms seek to export their products and services to secure larger contracts and growth opportunities. However, the export of defence technologies is highly regulated and subject to severe bureaucratic oversight. This can prove a major disincentive to small firms in seeking to expand their operations. However, securing defence contracts is often a long, drawn out process frequently involving significant political interference. Perhaps as a result of these factors, most of the firms engaged in significant export activity are large.

The Role of Government

The defence industry is closely intertwined with government and is heavily dependent on its policies. Defence budgets are highly variable and may change significantly with changes in government. In recent years Australia's defence budget has been influenced by events such as the need to commit peacekeeping forces in East Timor, the threats posed by international terrorism, and ADF commitments to military actions in Afghanistan and Iraq.

The Production Network Layer within the WA Defence Technologies Sector

Four defence case study firms (DCSF) were examined in this analysis of the defence technologies sector in WA. Three of these firms were commercial organizations and the fourth was the DMORO, which plays a crucial role in the local defence procurement sector. DCSF 1 is a specialist in the design, manufacture and supply of undersea combat systems. The firm is involved in systems engineering, integration, installation and project management of large-scale systems utilising its own, as well as third party, technology and products for the international defence market. DCSF 2 is engaged in software engineering for military command and control systems. DCSF 3 designs and develops 3D replay software and communications systems for military and intelligence agencies.

Within the production network the lead customers are the various arms of the ADF, namely the RAN, RAAF and ARMY. Each service has specific requirements and all firms had established close relationships with defence personnel within highly specialized parts of the military. For example, the requirements of the RAN for submarine systems, underwater battle space management, or mine countermeasures are quite different to the software systems requirements for the ARMY Aviation Corps Eurocopter Tiger armed reconnaissance helicopters.

This need for specialized knowledge of the defence technologies peculiar to each weapon system requires the firms in the sector to deal closely with different parts of the ADF. It was noted that although the senior commanders and decision makers in the Australian military were usually located in Canberra, the defence assets such as the submarines or

frigates were based locally. Depending on the nature of the project relations between firms and ADF elements could be either loose or highly integrated.

Production network layer of Defence Case Study Firm 1

DCSF 1 has contracts with the RAN and maintains regular contact with both the end users located in WA and senior decision makers in Canberra. For example, within DCSF 1 there was daily communication with ADF personnel, usually by telephone, and informal face-to-face contacts were conducted weekly or as required. More formal meetings took place on a monthly basis. This frequent contact was important to the firm's ability to develop its understanding of customer needs and widen its product offerings.

Knowledge of the end user needs was crucial for success. DCSF 1 explained that they had once tendered for defence contracts overseas but had been unsuccessful. In assessing their failure, DCSF 1 recognized that they had not adequately understood the real needs of the customer, and had not taken into consideration some of the technical and cultural differences between the Australian and foreign military. Most of the products produced for the defence sector require substantial adaptation before they can be incorporated into the military systems of each country.

The small size of the Australian defence market meant that DCSF 1 was looking abroad to secure international contracts that would enable the company to grow. The firm had embarked on a joint venture strategy that opened access to the USN, US Coast Guard, Royal Navy, Singapore Navy and Spanish Navy.

In addition to developing close relationships with customers, DCSF 1 enjoyed strong ties with several key suppliers. One such supplier was an engineering company that manufactured components for DCSF 1 products. The two firms were geographically proximate in their location and had established strong relationships between their respective management teams based on mutual trust as well as formal business contracts. The nature of this working relationship involved exchanging ideas, and specific information such as plans and technical drawings. After six years the relationship had strengthened and this had enhanced the quality of the production process.

Production network layer of Defence Case Study Firm 2

DCSF 2 also sought to forge strong personal relationships with both end users and key decision makers in the ADF. The complex nature of defence tendering and procurement means that government buyers require substantial input from suppliers. This has resulted in the need for managers to travel frequently to Canberra to speak to senior defence personnel. DCSF 2, for example, considered that success in the defence procurement process relied on the quality of the supplier's specific products, a proven track record, competitive pricing and financial stability. Government buyers prefer to deal with low risk, low cost vendors that are quality driven. From the tendering process onwards the decision-making by the customer was 'totally product based'.

Developing an understanding of the customer's needs was considered given high priority within DCSF 2. It was recognized that this process took time and required management and staff to maintain frequent contact with customers and suppliers. The firm sought to employ former ADF personnel who could 'speak the client's language'.

Interaction between the firm and its customers was necessary due to the highly customised nature of the products being developed by DCSF 2. Most defence projects

required continuous updating and maintenance of the software. The management of DCSF 2 took a long-term view of their relationship with its customers and aimed to deliver the highest quality service throughout the lifecycle of a project sometimes lasting several years. In addition to developing the products, DCSF 2 also undertook installation work, network design and value-added solutions.

In terms of suppliers, DCSF 2 sourced most of its needs locally via formal contracts that were generally highly specific in nature. Despite the formality of such agreements, the relationship between the firm and its suppliers was medium to weak in strength. Key suppliers were manufacturers of computer hardware and were generally chosen on the quality and reliability of their products. Although relations with suppliers were strengthening, DCSF 2 maintained predominately arms length relationships.

Production network layer of Defence Case Study Firm 3

Like the other firms, DCSF 3 acknowledged close physical proximity to the end users as highly important, particularly as design and development work required frequent exchanges. A concern for DCSF 3 was the concentration of ADF procurement and purchasing teams in Canberra. Prior to 1995 the Defence Department had maintained a local purchasing office in Perth that had a degree of discretionary spending authority that could be used to stimulate contracts with local firms. However, by consolidating activity on the east coast, WA-based firms were feeling 'left out of the loop'.

The geographic distance between Perth and Canberra created some problems for the firm in its endeavours to develop contacts in the defence bureaucracy. The DCSF 3 management also felt there was a need for greater transparency in the tendering process, with a need for better feedback as to why a tender was or was not successful. A further problem experienced by the firm in developing close customer relations was the high turnover of defence personnel. The firm would spend time getting to know a particular ADF member within a key position and develop a good working relationship. However, this individual would then be reassigned to a new posting requiring the process to start over again.

Collaborative arrangements between DCSF 3 and other companies in the defence industry were emerging as important to securing future contracts. There was an apparent preference within some areas of the ADF to encourage such alliances to avoid being criticised for favouring a particular supplier. As a small firm, DCSF 3 was cautious about such alliances, as many of the partners were significantly larger. Dealing with some of the major national or international defence companies was an opportunity but also involved substantial and lengthy legal deliberations over protection of intellectual property.

Small firms seeking to win contracts in the defence sector were also subject to resource limitations. Defence tendering and procurement processes were protracted and costly. According to DCSF 3 the smaller firms were something of an 'underclass' within the local defence sector and frequently found themselves at a disadvantage to the large companies. There was a view expressed that these large firms waited for the small ones to 'bleed dry', exhausting their resources as they attempted to win a lengthy tender, only to move in later and buy up the firm and its intellectual property at a discount.

DCSF 3 made use of sub-contractors in many areas of its production including software engineering. This was considered preferable to employment of full-time staff as the frequent fluctuations in the business cycle made it unfeasible to carry a large permanent

workforce. Following the recession in the ICT sector, the supply of experienced software engineers was quite high.

The Resource Network Layer within the WA Defence Technologies Sector

An important player in the resource network layer of the defence technologies sector is the DMORO. This agency gathers information and market intelligence on the industry and provides advice to the Defence Department, while serving as a channel of access and information to the defence industry from the military. Due to the need for commercial fidelity and probity, all DMORO activities are conducted at arms length and no personal contacts are assumed to exist. The DMO maintains links to the various state and territory governments and aims to establish knowledge and capability networks that will assist them to service the needs of the ADF. The strength of these relationships various from network partner to network partner, but is restricted by the commercial fidelity and probity issues facing the DMO. The DMO views the WA defence technologies sector to be 'small but competitive'. WA is viewed as having particular capabilities in maritime and marine engineering. South Australia is a major competitor to WA and its ICT sector is more prominent within the defence sector on a national level. DMORO has no direct responsibility for purchasing decisions. All purchasing takes place in Canberra.

Resource Network Layer of Defence Case Study Firm 1

Key actors within the resource network of DCSF 1 were the government, universities and the major international defence systems manufacturers. The products designed and developed by DCSF 1 had the capacity to be integrated into a range of weapons systems, thereby placing them under the regulation of the International Trade of Arms (ITAR). The firm was engaged in frequent communications with the ITAR regulators, typically on a quarterly basis, over its export activities. These relationships were generally arms length in nature.

Within both the domestic and international markets, DCSF 1 had established links to several major defence systems manufacturers. Some of these alliances were 'enforced' upon the firm as a result of complex defence contracts requiring multiple tenders and suppliers. DCSF 1 possessed specific expertise that was required to complete all aspects of a given project, providing the firm with a portion of a much larger defence project. Such alliances were relatively formal and related directly to the tasks required. There was little strength in these relationships.

Contact with the local universities was limited to the recruitment of graduates and the occasional sub-contracting of academics to assist in the 'cracking of harm sums'. Such collaboration over R&D was sporadic and infrequent, although the managers from the firm possessed personal relationships with local academics.

Resource Network Layer of Defence Case Study Firm 2

Regulation by the ITAR also influenced the activities of DCSF 2. Because its products were classified as dual use technology, it was necessary to acquire ITAR approval for exports and end-user certification was required. The government had also sought to assist small local firms by restructuring tendering procedures to require large firms and multinationals to include small businesses as project partners. This had drawn DCSF 2 into alliance with other local firms. According to DCSF 2 managers, the type of partner sought for such alliances are firms that offer complimentary skills or capabilities. Such partners should also have good reputation and be expert in their fields. Although such

alliances involve establishing effective working relations, the strength of such partnerships remains medium to weak and needs more time to fully develop.

Resource Network Layer of Defence Case Study Firm 3

For DCSF 3, one of the most valuable elements within their resource network is attendance at the major defence expositions and trade fairs. Such gatherings offer the company an opportunity to showcase its products, and also network with other firms and potential customers. Another aspect of the firm's resource network is its well-established pool of sub-contractors. This network has been established over time and is based on a combination of formal and informal agreements depending on the nature and intensity of the projects at hand. The mobility of this sub-contractor network offers DCSF 3 a flow of information about activities within the defence sector and enables the identification of market opportunities and additional human capital as well as updating industry knowledge.

There was little discussion by any of the three case study firms about venture capital. Both DCSF 1 and DCSF 2 had achieved growth over past years via trade sales, enabling them to secure external equity from major international parents. By comparison DCSF 3 was still privately owned and small in size. While not dismissing the importance of venture capital, the management of DCSF 3 expressed concern over dealing with such sources of finance. Their perception was that the local venture capital sector had performed poorly in relation to assisting small ICT firms, conducting themselves in a 'ruthless' manner and abandoning firms with little warning.

The Social Network Layer within the WA Defence Technologies Sector

All firms recognized the importance of maintaining close personal relations with a strong network of contacts in the defence and related industries. This was particularly important with the military, which could be a difficult culture to penetrate. Each firm addressed this social network in their own way. DCSF 1 and DCSF 2 had employed former ADF personnel who assisted in networking the companies back into the military. Social functions and sporting events such as golf days were arranged or sponsored. Senior managers also joined defence associations and met contacts via conferences.

Networking was encouraged at all levels of these firms but each firm had slightly different views on its merits and purpose. DCSF 3 saw social networks as an important way of compensating for the otherwise impenetrable, if not 'unworkable' defence bureaucracy. Social networks retained from previous projects or military-defence employment assisted the managers of these firms to keep informed of industry trends and opportunities. Such social contact also occurred between employees from the various firms within the local WA defence industry sector. The management at DCSF 1 saw social networks as more important for retaining existing customers than wining new business. It was noted that social links developed in Perth were of little value when seeking export markets. Here the firm had to establish its own network of contacts with foreign military and defence personnel.

In addition to social networks that could support the production activities, the firms also retained contacts within the academic research community. All case study firms had social networks to the local universities, particularly the University of Western Australia and Curtin University of Technology. These relationships were mostly personal friendships that had begun to develop into explorations of more professional linkages. There were also cases of academics being engaged to undertake consultancy work or

collaborative research projects. All such links were fairly limited and weak from a commercial perspective.

General Assessment of Networks within the WA Defence Software Sector

The defence software sector in WA is composed of a small number of highly specialized firms focusing on the relatively few defence contracts available in Australia, and seeking to move into export markets as soon as they can to ensure continued business growth. Within the local defence market the DMORO plays an important role, but is constrained in its capacity to collaborate. There is a psychological 'high fence' surrounding the DMORO making it difficult for its staff to establish strong personal ties with participants within the sector. The DMO organises an annual Defence and Industry Conference that offers firms an opportunity to network, and also conducts Regional Briefing Programs throughout Australia to follow up key issues arising from the conference. According to the DMORO, those recently held in Perth attracted around 100 people.

Within the production network layer of the defence software sector relationships are more arms length than true partnerships and more formal than informal in nature. In the resource network layer the scale and scope of relationships were even more limited. Although firms had some linkages in this area, most were weak and ad hoc. Interaction between firms and universities, financial institutions, venture capital providers or government agencies were generally limited. Finally, while the social network layer was recognized as important to business, it was frequently constrained by the need for secrecy.

The industry is disadvantaged by the geographic distance between Perth and Canberra and the relatively low concentration of defence industry within the state. Exporting offers the main opportunity for growth, but requires a degree of compliance burden due to the requirements of ITAR regulations. On the positive side there are examples of strong, long-term relationships base on mutual trust having been forged between firms, and the emergence of a network of closely interrelated and interconnected firms. This was particularly noticeable within the naval sector of the industry with work surrounding the RAN Collin's Class submarines.

Chapter 9

Sector in Search of a Definition

The E-Business Services Sub-Sector

Originally it had been the intention of this research study to examine the WA security technologies sub-sector that is engaged in the design and development of advanced high-speed networks, e-business systems and related management and security technologies. The sector provides products and consulting services to firms, frequently large organizations that require data integrity and security for corporate databases and computer networks. However, the security technologies sub-sector is poorly defined and spans a range of diverse technologies, from system software packages to car alarm devices. Firms initially identified as being located within the security technologies sector were actually engaged in a variety of quite different activities, including drug detection and car alarms. As the study progressed it became necessary to shift the focus from the security technologies sub-sector to the e-business services sub-sector.

Five case study firms (ECSF) were examined for the investigation into this sub-sector. Four of these – ECSF 1, ECSF 2, ECSF 3 and ECSF 4 – were engaged in e-business services provision. The fifth was the local branch of a large multinational corporation and was included in this analysis due to the role it was found to play within the sector.

The Industrial Market System of the E-Business Services Sector

The e-business services sector involves the servicing of a client organization to enable it to use electronic equipment and supporting activities within their business operations. The sector has an IMS consisting of four to five distinct activities or functions. The first of these is the initial task of marketing the products and services of the firm to its prospective clients. Once a contract is secured the firms engage in business consulting, a phase during which they assess and define the business needs of the client. In the next phase the firm designs a technical solution for the client that is subsequently built. The solution-building phase typically involves programming, application customisation and related software engineering. In the final phase, the firm delivers the solution to the customer thereby completing the contract.

Each of the case study firms examined for this study followed a similar pattern in the approach to delivery of their services. Figure 7 shows the general value chain structure of these firms. ECSF 1, 2 and 3 were small to medium sized firms with operations in both WA and international markets. While ECSF 1 and 2 provided all activities, and focused heavily on the consulting phase, ECSF 3 was a supplier of only software development and technical services and did not engage in business consulting. Finally, ECSF 4 was a branch office of a much larger international company offering integrated business consulting and information technology services to business and government.

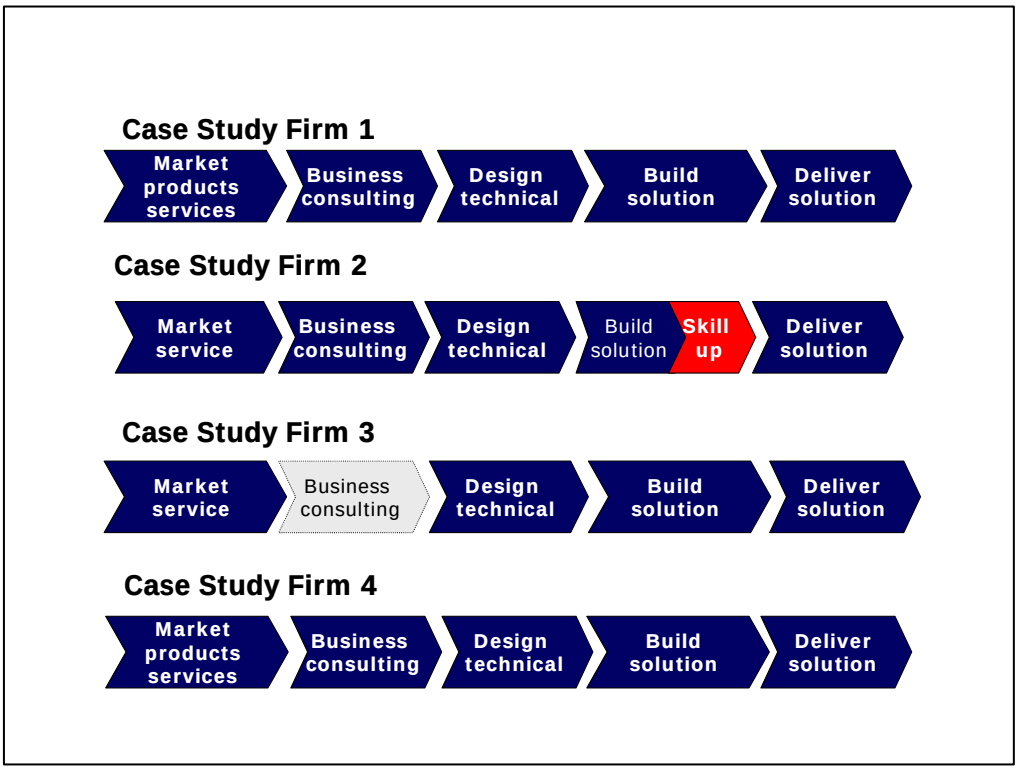

Figure 7: The WA E-Business Sector Industrial Market System

The general structure of the WA e-business services sector is that of two distinct groups of firms. On the one hand are the large vendor/services organizations such as IBM, Microsoft and Sun Microsystems. These firms hold dominant places within the local market and control access to major consumers, technologies and opportunities. On the other hand are small to medium sized firms that are dependent on these larger companies for access to their technologies, or to serve as lead customers. Microsoft, for example, has a relatively small operational base in WA, but is highly influential in the market through its product technologies and third party user support network.

For the smaller firms in the WA e-business sector the power of these large firms is supplemented by government agencies that comprise a large proportion of the industry. The impact of the government is compounded by the state tendering process that was viewed by many of the firms who were interviewed as designed to encourage a 'bidding war' likely to favour larger players. It was also argued that the tendering process discouraged firms from collaboration with government agencies pre-tender because of the apparent lack of recognition of such activities within the tender evaluation process.

The Production Network Layer within the WA E-Business Services Sector

Within the production network the primary sources of revenue for all firms are derived from vendor product support, software development and general ICT services. The major vendor/services firms provided the core technologies used by the e-business services firms to build business models for clients. This places a high priority within the sector on

the development of third party alliances and networks. All the larger firms were found to have a range of formal and informal mechanisms to identify, engage and manage third parties and seemed willing to partner with both small firms and other large companies. By contrast, small firms appeared to engage in less partnering and saw other small firms as competitors that were vying for the same 'slice of the pie'.

Within WA most firms appeared to focus on the same set of customers in what is a very small market. The highly competitive nature of the local market and the tight profit margins involved, particularly for small firms, was a major impetus to seek overseas contracts. All the small firms were engaged in international projects and one had actually established a joint venture offshore.

Production Network Layer of E-Business Case Study Firm 1

An objective of ECSF 1 was to target 'blue-chip' customers within both the local and international markets. The production network of the firm comprised a number of high profile clients within government and industry. All its lead customers were large organizations and ECSF 1 attempted to fully service their requirements. However, this was not always possible and the firm maintained a variety of alliances with other firms capable of supplying equipment and services. Within this alliance partner network were several multinational corporations. Many of these alliance partners were also key suppliers, offering technologies and expertise. Included in this production network were local and overseas universities principally for services.

Production Network Layer of E-Business Case Study Firm 2

The management of ECSF 2 pride themselves on the offering superior value for money than most of the larger firms with whom they compete. A key focus for the firm is quality and the delivery of excellence in services. The firm provides services that require human capital, market research data and both software and hardware. Key suppliers to ECSF 2 included personnel recruitment and selection agencies, global market research providers able to supply data on trends in technology and business activity, and vendors of hardware and software systems. The firm's relationships with these key suppliers were strictly commercial and not particularly close.

Lead customers with the local market included large government and industry 'blue chip' organizations of the same kind targeted by other firms in the sector. The firm strived to maintain close partnerships with all customers as this was viewed as critical to securing future business. ECSF 2 had developed strong links with lead customers in international markets both directly and via a joint venture with an offshore partner. In the view of the firm's management this international joint venture had provided ECSF 2 with a lower risk entry strategy to a lucrative foreign market. The joint venture partners were able to supply both local knowledge and specific technical skills.

Production Network Layer of E-Business Case Study Firm 3

ECSF 3 had established relationships with key suppliers such as IBM, Microsoft and Sun Systems to secure access to new technologies and to assist in identifying potential new business opportunities. These relationships were dynamic and largely informal in nature. As a small customer ECSF 3 had to make the effort to strengthen these links rather than expect this to be driven by the suppliers. ECSF 3 also held fears of such suppliers deciding to move forward in the production channel and compete directly with it.

The company had only a few large lead customers and was generally reluctant to collaborate with local firms in alliances to service such clients. According to the firm's managers, there had been attempts made to engage in such collaboration during past years. However, these experiences had not been positive due to overlaps in service offerings. The company was willing to collaborate so long as its partners were not likely to threaten its own business. Within the international arena, ECSF 3 had secured a contract in Asia though an alliance with a major hardware systems manufacturer to service the needs of local manufacturers in the target market.

Production Network Layer of E-Business Case Study Firm 4

A feature of the production network layer of ECSF 4 was its capacity to generate the majority of its business from word of mouth referrals. The firm's main lead customers were state government agencies and private sector organizations with headquarters in Perth. ECSF 4 attributed much of its innovation activity to the influence of these lead customers who placed demands on its staff to constantly improve and respond with new ideas. In addition, having such good customers assisted the firm to establish firm best practice benchmarks and promote its credibility to others. The company also serviced a variety of small firms within its customer base. It separated the local market into large corporate clients and small businesses.

The relationship between ECSF 4 and its customers were secured by formal agreements, but the actual strength of these links had been growing from arms length to something closer over time. ECSF 4 was a participant in many non-exclusive technology transfer relationships with suppliers. Its list of key suppliers was quite large and included many of the major producers of hardware and software in the world. These suppliers were acknowledged as an important source of ideas for subsequent innovations.

Production Network Layer of Multi-National Case Study

Also examined was the state office of a large multi-national corporation (MNC) which was profiled due to its ability to illustrate the role such organizations play within the WA ICT sector. This MNC Case had a strong presence in all major market segments within the local ICT sector as a supplier of hardware, software and related services and technologies. This company has a substantial range of customers within the state covering almost all industries and government departments.

The approach taken by the MNC to business development was the establishment of a close partnership arrangement with major customers, seeking to secure as wide a scope of the client's business as possible. In addition to its major customers, the MNC had a broad network of third party alliances that it managed via a series of formal programs. This alliance strategy was seen within the management of the MNC as a means of offering a comprehensive range of products and services to its customers. This was necessary in WA, which was viewed as a small, remote market unable to justify the company expanding such services internally. Although it was a global corporation with significant scale and scope at the international level, the MNC Case had relatively resources in WA and found that a large network of third party allies was an effective means of covering territory.

As the MNC Case was able to originate its own leading edge R&D, products and services, its local office drew upon the resources of its parent company for supply of technologies and related services. Ideas and information on latest innovations were fed through to the Perth office and transferred on to customers via a technology-push innovation process.

The Resource Network Layer within the WA E-Business Services Sector

An interesting aspect of this sub-sector was the structure of its resource network layer. Due to the nature of e-business services, the resource networks employed by the various case study firms included many of the same partners as were found within the production network.

For example, ECSF 1 had a resource network that included alliances with key suppliers for access to technologies and services required in its production process. Included in this resource network were two universities (one based in WA and the other overseas), as well as the agencies of a foreign government within one of its international markets. The same situation was found within the resource network of ECSF 2, which had even secured direct investment from one of its lead customers and who had a minor share holding. This lead customer/shareholder was viewed as a potential source of additional capital in the event that ECSF 2 needed to scale up its operations rapidly.

All case study firms indicated that they obtained the majority of their ideas for innovation and market intelligence via the Internet. This also extended to online access to new software technologies from key suppliers. ECSF 3 had also secured a link to the CSIRO over a collaborative R&D project. This had resulted in a prototype product being developed with associated patents. However, the management of ECSF 3 expressed some frustration at the commercialisation process within CSIRO. While the agency was considered an excellent source of research ideas it was considered to be too slow with respect to commercialisation, and lacking a clear process for such commercialisation. Protracted legal negotiations between ECSF 3 and the CSIRO had been a feature of the project and such delays made it unlikely that the firm would be keen to engage with the federal agency again.

One of the features of the resource network layer in the e-business services segment was the ability of participants to readily overlap into each other's production networks. Concerns over the possibility that alliance partners may seek to poach customers had led many firms to avoid collaboration within the local market. Key suppliers were not viewed as particularly troublesome in this regard, partly because they were unwilling to upset their own customers and be excluded from the network. An example of this was ECSF 4. This firm drew resources from a variety of key suppliers, lead customers, government agencies and alliance partners. Each member of the network contributed its respective competencies and skills without significant technology transfer. There was an unwritten rule that participants in the network did not step on the competency area of another alliance partner; otherwise they would be excluded from future participation.

For the MNC Case the resources available within the parent company provided a situation of near autarky. However, as noted above the firm had established a large network of third party alliance partners within the local market. In addition to these alliances, the MNC Case had, or was seeking to create linkages with the local WA universities and the CSIRO.

The Social Network Layer within the WA E-Business Services Sector

The highly competitive environment in which the firms were operating, and the fear of losing customers or staff through such interaction influenced the social network layer within the sector. ECSF 1, for example, avoided collaboration with other local firms and was rather dismissive of the capacity for such cooperation among WA ICT firms. The

small size of most firms meant that they were frequently focused on survival and rarely had time for non-business relations or interaction with others.

A principal use of social networks for firms was to secure new business opportunities. ECSF 2 that participated actively in a variety of industry or business and technology seminars and the Australian Institute of Management (AIM) demonstrated this. Such networking was aimed at promoting the firm and its capabilities to prospective clients. The company's managers to promote to key decision makers in customer or prospective customer organizations also used personal social networks actively. It was the view of ECSF 2 that the only way to win business in Perth was to put in significant amounts of face-to-face contact time. Further, when targeting new business opportunities, the firm was often found to need the participation of a specialist consultant or sub-contractor to fill in gaps in the company's own expertise. Such people were usually sourced via the personal networks of the firm's managers.

This mixture of professional and private relationships was a common feature of firms and included present and past customers, key suppliers, industry associations, former employees, other consultants, sub-contractors and organizations such as the AIM. This process of managing a useful social network had been formalised by ECSF 3, which had established a small advisory panel of key experts comprising skills in marketing, finance and business planning to assist the firm's overall growth. Interestingly ECSF 3, despite having within its social network some expertise in venture capital funding, expressed the view that venture capital financing was too difficult and carried too many compliance burdens. The company management had a preference for debt financing and not diluting the owner's shareholdings. Participation in the E2B forums was noted as a useful means of surveying the venture capital market, and acquiring new business opportunities.

Other activities designed to grow and strengthen the social networks of these firms were corporate sporting events, memberships of professional associations, attendance at industry breakfasts and dinners, participation in trade shows and direct face-to-face communication. This was a pattern common to both the small and large firms. For example, the senior manager of the MNC Case retained a large personal social network that included membership of chambers of commerce (both local and international), the Australian Computer Society, and CEDA. It also involved links with political parties on both sides of the parliament.

General Assessment of Networks within the E-Business Services Sector

The e-business services sector can be generally described as having a production network layer dominated by large firms – particularly key suppliers – that also provide a source of ideas, technologies and related services across the resource network. Small firms in this sector are relatively reluctant to collaborate with each other due to fears of competitive poaching of customers and overlapping of services. The margins generated by this service-based sector are usually tight and competition is severe. Many case study firms were moving offshore, usually via alliances, to secure more lucrative contracts.

Government agencies dominate the sector, both as customers and potential competitors. The state government tendering process was viewed as encouraging bidding wars that only favour larger firms, usually foreign or non-WA owned. These same tendering requirements were also viewed as discouraging to collaboration with government agencies due to the lack of recognition in the process of such activity. Strong personal networks were a critical source of new business development. Lack of access to local venture financing appears to be a source of constraint for many firms.

Finally, there was found to be a limited relationship between the small firms and the local universities or government research agencies such as the CSIRO. While some links were evident, most firms expressed the view that such relationships were difficult to extract value from, particularly since there appeared to be no formal mechanisms in place to facilitate the commercialisation of innovative ideas or products. The case of ECSF 3 that had engaged with the CSIRO in a collaborative research project was disappointing due to the reluctance of the company to repeat the exercise. In contrast the MNC Case was actively engaged in these R&D alliances and was seeking to expand them.

Chapter 10

Real Estate, Good Intentions and Search for Clusters

Technology Park Bentley

The Technology Park at Bentley (Tech Park) in the south east of Perth is home to many of the state's ICT firms. As a technology park the area is of interest to policy makers for its potential to serve as a focal point for the creation of clusters of technology-based industries. The success of such projects as the Research Triangle Park in North Carolina, USA described in Chapter 4, has led many state governments to invest in the creation of science parks. In investigating this area the methodology used differed slightly from that employed in the other sub-sectors. Using the database of ICT firms located within the Tech Park contact was made with a prominent ICT firm based there, and additional data was collected from interviews with a range of other key organizations and individuals. This included Zernike Australia (the manager of the park), Entrepreneurs in Residence (an ICT incubator), Chair of the Technology Precinct and AOT Consulting.

An Overview of the Technology Park Bentley

It has been estimated that there are approximately 23 technology parks in Australia, nine of which have incubation facilities and eight of which are linked to universities (Hilliard, 2001). Australia has tended to follow world trends in the design and structure of its technology parks with strong influences from Europe and North America. The principles upon which such parks are founded are in line with the concepts of the techno-economic network (TEN) structures discussed in Chapter 4. While universities, government and the private sector have some common interests in operating technology parks, they do not share the same priorities for achieving pre-determined outcomes from park activities. A critical issue for technology parks is the characteristics and quality of their management. Where technology parks are closely associated with universities it is usually desirable that there be a clear separation of the park management from that of the university. This is due to the need for enhanced commercialisation, efficiency and responsiveness to the needs of the market

Tech Park was established in 1985 under provision of the Technology and Industry Development Act (1983). It is now administered by the State Government of WA and managed by Zernike. The Tech Park is situated on 43 hectares of land within the Technology Precinct, which itself covers an area of 314 hectares of crown land, consisting of numerous organizations including education, research, industry and recreational facilities. The Curtin University of Technology and Swan College of TAFE are also grouped within this precinct. The park provides accommodation for around 82 organizations and 2,500 employees. Over half of all firms located in the park are engaged in R&D, and the majority have export markets. In 2001, Tech Park firms generated an estimated AUD$500 million in gross revenues.

Four major industry groups are located within Tech Park. ICT firms comprise 28 percent, resources and energy industries around 25 percent, services 21 percent and biotechnology 10 percent of all firms. The remaining firms are engaged in education and support.

A review of international research into technology and science parks suggests that at least four key success factors are important for the success of such parks. First, there must be adequate real estate designed with the intention of creating an environment conducive to creativity and innovation. Second, there must be present high quality managers who can assist in the commercialisation of R&D, but not strangle creative talent. Third, there must be harmonious relationships between firms in other industries and supportive resource network communities. Finally, the location of the technology park should provide attractive lifestyle features (e.g. good housing, schools, climate, cultural, recreation and sporting facilities) (Cao, 2001; Einhorn, 2001; Pfeffer, 2001; Blau, 2001).

A noticeable feature of Tech Park is its pleasant physical environment. The park boasts well-landscaped verges and attractive gardens, complimented by modern buildings and good parking access. There is a function centre and restaurant located onsite. In fact a survey of Tech Park firms found that 91 percent of respondents had chosen to locate there due to the pleasant surroundings. The park is also reasonably close to the airport and Perth CBD, and has a prestigious image. It also has access to high bandwidth communications infrastructure and other ICT services. Interestingly the close proximity of Curtin University was considered by most firms in the survey to be of little importance.

Strategic Objectives and Planning Scheme of Technology Park Bentley

The State Government seeks to use Tech Park to assist the provision of technology-based infrastructure for technology-based enterprises. By providing an environment for innovation, it is hoped that Tech Park will provide a catalyst for science and technology development within WA.

Firms seeking to gain entry to the park are required to demonstrate that they will undertake activities in at least one of the following areas: R&D, product development and improvement, supply of technology-based products, or provision of specialist services to increase the capability of other firms in technology. The park is also regulated under the planning schemes of the Town of Victoria Park and the City of South Perth. This planning scheme restricts the scope of retailing and manufacturing activities within the park, and supports the objective of focusing on the development of technology incubators.

Both Zernike and the State Government seek to nurture national and international linkages between Tech Park and other centres of technology. The State Government regularly hosts delegations of overseas visitors to the park with a view to forging potential trade opportunities for firms. The park management is also linked to the global community of technology parks via the International Association of Science Parks (IASP). Tech Park has been nominated by IASP as the co-ordinator of the trial International Association of Science Park Network (IASPNet).

The Strategic Networks of an ICT Firm in Technology Park Bentley

To gain an understanding of the networking behaviour of firms operating within the Tech Park a case study firm (TPCSF) was selected from among the ICT firms located in the area. TPCSF was selected due to its relative prominence within the sector. This firm was a producer of leading edge software systems and was actively engaged in international markets. TPCSF had lead customers located in North America and these included several multi-national corporations. Key suppliers to TPCSF were harder to identify as the company did not consider that any of its suppliers to be essential to its production. Nevertheless the list of suppliers to TPCSF included many hardware and software firms.

The management of TPCSF consider Perth to be a market that is too small for any substantial growth, but an environment in which there is an absence of serious competition. This lack of local competitors was viewed as a positive because it resulted in a low turnover of key staff. By comparison, if TPCSF was located in Silicon Valley during the boom period staff turnover was between 6 and 12 months. The company also sought to pay employees attractive salaries and offer them opportunities to travel to visit leading centres of software engineering such as the United States. These policies had ensured a high retention of staff. Although the geographic distance from Perth to TPCSF customers in North America was substantial, the firm's management did not consider it of importance. Time and space were compressed with the Internet and international jet airliner.

The main reason cited by TPCSF for being located in Tech Park was its proximity to the home of the CEO. The facilities of Tech Park were acknowledged as good, but not sufficient to justify a location decision by themselves. Despite the active work of the management of Tech Park (Zernike), TPCSF management did not devote much time to participating in collaborative networks with other firms in the park. There was little value seen in such networking, as TPCSF could not identify any value adding opportunities.

With respect to the resource networks used by TPCSF, the firm was found to have strong relationships with accountants, patent attorneys and other professional support groups. However, these relationships were largely arms length in nature with little evidence of a collaborative partnership. Such professional advisors would be contacted to provide specific services such as related to corporate governance or intellectual property issues.

TPCSF considered WA to have excellent universities and an attractive lifestyle that was 'second to none'. However, the firm had little contact with the local universities and saw no need to seek collaborative research links. There was an equal reluctance to collaborate with government. TPCSF management considered it was 'just too difficult' to deal with government authorities in Australia. Government assistance in the form of R&D start up grants was viewed as too problematic and burdened with compliance costs. It was better to 'hop on a plane to New York, London or Silicon Valley' to seek funding than to rely on government support programs. There was also criticism expressed by the firm's management over a lack of clear strategic direction in terms of government policy (both at the state and federal level) to support local technology firms.

The Strategic Networks of Zernike in Technology Park Bentley

Zernike Australia is the managing agent for Tech Park and is part of the Zernike Group, a Dutch-based technology development company with international operations. Zernike provides facilities management and ancillary support contracts to science parks and is regularly engaged in a wide range of projects. It actively networks with innovators, small firms, universities, support service providers and government agencies with a view to identifying investment and commercialisation opportunities. At the production network layer, Zernike provides a corporate structure and management expertise in the pre-IPO stage of commercialisation, and seeks to link start-up firms with corporate customers and venture capital sources. In addition to managing Tech Park, Zernike also manages the Brisbane Technology Park and has an office within the University of Technology Sydney where it is responsible for assisting the commercialisation of university research. Within Tech Park, Zernike maintains a resource network that draws together a series of alliances designed to enhance its production network. An examination of the alliance networks of Zernike is revealing of the wider ICT sector activities occurring within Tech Park.

Entrepreneurs in Residence

Among the alliance relationships Zernike maintains within Tech Park is that with the technology incubator Entrepreneurs in Residence (EiR). Zernike is an equity partner in EiR and holds a 30 percent stockholding. EiR which was established with a federal government grant of $10 million under the 1999 Building on IT Strengths (BITS) initiative, designed to enhance the growth and competitiveness of Australia's ICT sector. Through this alliance Zernike maintains links to the Federal Government.

In selecting firms to accept within its incubator EiR looks for firms in the early stages of development that require seed capital financing up to a cap of $400,000. Such candidates are required to be engaged within the ICT industry (as defined under the BITS initiative) and should have a high quality management team. Of interest was a recent shift that has taken place within the EiR selection process from a focus principally on the commercialisation potential of the IP within a firm, to the management team operating the company. This shift resulted from some differences of opinion between the management of some firms brought into the incubator, and the management of EiR, over how the company should be run. EiR had been forced to 'let go' a number of investments due to conflicts with the management teams of the candidate companies.

Today, EiR places a much greater emphasis on the nature of the relationships that can be developed between its own people and those of the candidate firm. The importance of establishing a strategic partnership with firms in which it invests was acknowledged. In addition, EiR now funds incubator firms incrementally, with clear milestones set against performance targets for receipt of future funding, and against a sound business plan.

Software Engineering Australia

An important actor within the resource network of the ICT sector in Tech Park is Software Engineering Australia (SEA). Established in 1998 with Federal Government funding, this organization is a provider of tools and techniques designed to improve the development processes within small ICT firms, and thereby assist in reducing start up risk. SEA will facilitate knowledge and skill acquisition, providing access to a broad array of resources. These are aimed at assisting new ventures accelerate learning and by-pass trial and error knowledge acquisition. For example, SEA provides training and tutorials in software engineering practices designed to facilitate best practice within the industry. It also assists start up firms to identify and access additional resources and funding grants offered by Federal and State Government agencies, business partners and service providers.

SEA has active points of presence in a number of Australian cities and coordinates a National Information Network, Annual National Software Conference, as well as other seminars, workshops, forums and training programs. SEA also contributes to the dissemination of knowledge throughout the industry via publication of a journal and the hosting of networking opportunities within the software industry.

Technology Precinct Management Board

The Technology Precinct Management Board serves as a forum through which Zernike can maintain links to Curtin University of Technology and other academic networks. Zernike provides the Board with executive support and thereby has a strong linkage. However, the relationship with Curtin University outside the Board environment has been relatively weak despite attempts by Zernike to strengthen such linkages.

AOT Consulting

Zernike also has a strong alliance with AOT Consulting, a firm that provides expert advice and information on the ICT industry. AOT Consulting has been actively engaged in the evolution of Tech Park since the early 1990s. It has undertaken several studies on the Tech Park and science parks both nationally and internationally. AOT Consulting is a source of professional service support to Zernike, and plays an important role within its resource network layer assisting to shape strategies relating to the management of the park.

Social Networks within the Technology Park Bentley

One of the tasks actively pursued by the management of Zernike within Tech Park is the development and maintenance of a large social network. Within the park, Zernike facilitates regular social networking opportunities such as sundowners and guest speaker events. There is also a personal contact between the CEO of Zernike and the management of the majority of firms within the park. Externally, Zernike is able to draw upon an international network of contacts via Zernike offices in the Netherlands, UK, Malaysia, Italy and elsewhere. The ISAPnet also assists the development of the network. Zernike management also maintain personal links with venture capital sources and business angels both in Australia and overseas.

General Assessment of the ICT Networks in Technology Park Bentley

This examination of the ICT networks within Tech Park suggests that strategic alliances do exist at senior levels of management across many firms, but there appear to be stronger and more valuable networks that link these individuals to their international contacts. Within the park, the level of between-firm linkages seems low and it was not possible to identify the existence of strong industry clusters as defined by international research (Enright and Ffowcs-Williams, 2000). Apart from the comparative advantages offered by Perth's attractive environment and lifestyle, and a pool of relatively low-cost skilled workers, it was difficult to identify any sustainable competitive advantages that could not be easily replicated by competitors in other countries. Zernike shared this view, agreeing that there was little evidence of an ICT cluster (or a cluster of any kind) currently operating within Tech Park.

On a positive level, Tech Park has been relatively successful within the national context. Zernike considers itself to be a key factor in achieving this success due to the commercial focus it has when compared to alternative government run management structures. There is a long-term emphasis being placed on the development of clusters that can strengthen the international competitiveness of the state's industries. Zernike's program of facilitated forums; luncheons and speakers events are designed to provide a suitable social exchange arena where ideas and information can flow. However, not all firms in the park view such events as valuable, a point emphasized by the management of TPCSF.

Tech Park has established a reputation for excellence in innovation within some areas and has begun to concentrate R&D activities in such fields as mining, energy, biotechnology and health. If links can be established across industries, it may be possible to guide ICT innovation into other areas of potential competitive advantage and need such as water management and clean power technologies.

Given the small size of the WA market, it is essential that firms establish international networks and an export orientation. However, it is also important that there exist strong

links at the local level, at least in the resource and social networks layers. Despite the efforts of groups such as Zernike or the Technology Precinct, the level of interaction between firms remains low. Collaboration between the university sector and the firms located in the Tech Park also remains at a low level, despite the relatively high profile and presence of Curtin University within the precinct.

An examination of the TPCSF case suggests that Tech Park may be viewed as essentially a springboard for incubators and start-up firms that offers comparative advantages (e.g. lifestyle, lower costs, good transport access). However, once a firm has moved beyond the initial start-up phase and commences to grow the advantages offered by the park are diminished. Of greater importance to such firms is access to increasingly higher quality of business management talent, venture capital, high-level technology transfer and R&D collaboration, and access to global supply chains. In these areas the environment offered by the park are relatively weak.

The Perth ICT Triangle and Communities of Interest

The small size of the local WA market and the lack of scale and scope in the ICT sector makes it difficult for the development of a resource network layer of sufficient strength to enhance the sector's international competitiveness. By comparison with its counterparts in North America or Europe, the ICT sector in WA lacks scale and scope in its operations and related and supporting industries. The need to create a wider milieu for Tech Park appears to be reflected in the establishment of the Technology Precinct that seeks to encompass not only the immediate Tech Park area, but also adjacent organizations such as Curtin University of Technology.

From the perspective of industrial clustering, the current Tech Park is probably too small in size to generate the necessary linkages and concentration of resources required for sustainable cluster growth. This raises the possibility of a Perth ICT Triangle, which would seek to unite the main concentrations of ICT firms and their lead local customers into a larger network of activities. Using Tech Park as a centre of innovation for themed incubators, there could be a progression of companies reaching the production phase to be encouraged to relocate to alternative sits such as Osborne Park / Herdsman where a large part of the ICT supply industry resides. ICT research institutions associated with Curtin University of Technology and the University of Western Australia could bind the triangle. Other concentrations of ICT firms within Nedlands and West Perth could be linked into it. Figure 8 illustrates this Perth ICT Triangle concept.

It is necessary for the future development of the ICT sector that Tech Park continue to develop as a focal point for themed technology incubators, and that there be a consolidation of existing expertise among those firms that already have a demonstrated track record. While Tech Park has achieved many successes there remains a need for an enhanced level of collaboration and networking. There remains a lack of the necessary communities of interest that have the potential to facilitate innovation through interpersonal interaction. The efforts of groups such as Zernike and SEA aside, most firms within Tech Park operate in relative isolation from each other. Despite the attendance of senior managers to various networking functions held within the park, the stereotypical profile of employees within the area is of time-poor, task focused, socio-isolates that live for technology.

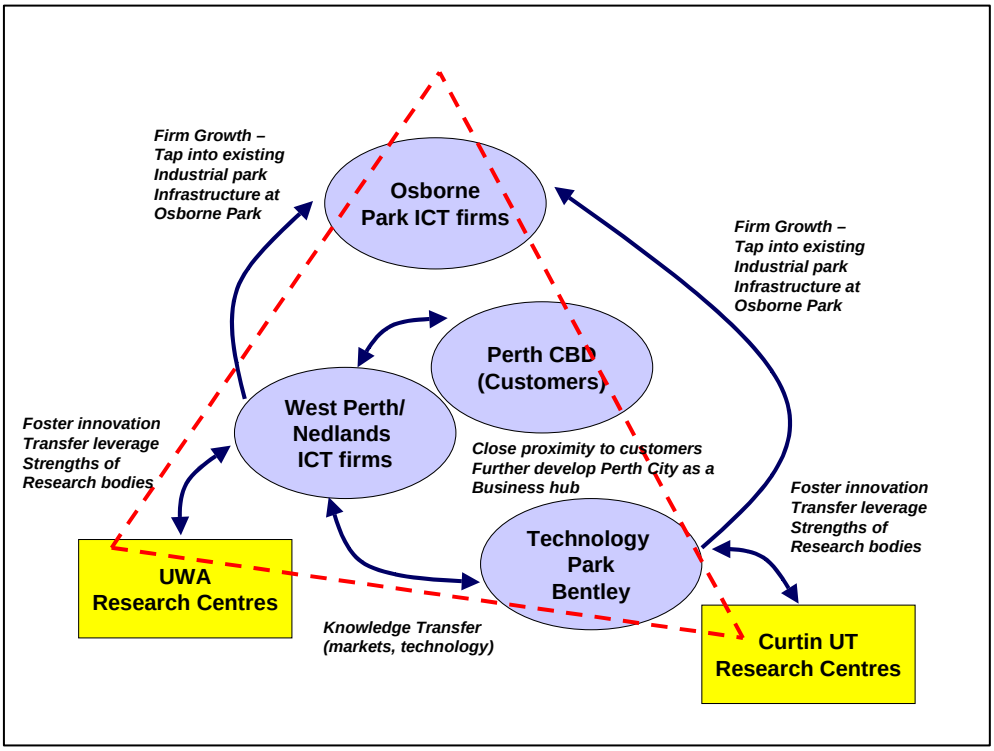

Figure 8: The Perth ICT Triangle

While the abovementioned perception of those who work in Tech Park may not be entirely accurate, there would appear to be a need for greater social interaction opportunities. After hours Tech Park becomes a ghost town with limited opportunities for employees to interact. Information sharing could be enhanced through the establishment of computer databases that would assist firm to identify professional support services and skilled expertise. On the technical level, there could be an internal website to canvass generic technical problems and solutions and the sharing of ideas. Finally, greater opportunities for social interaction through science carnivals, sporting activities, upgraded food services and the creation of a village atmosphere would serve to assist the process of social interaction. However, all such initiatives are only likely to succeed if the firms within the park support them. For busy managers and staff, the time taken to engage in such activities is unlikely to be found unless there is an expectation of a direct benefit emerging.

Chapter 11

Specialization, Commercialisation, Venture Capital and Education

Conclusions and Recommendations

One of the objectives of this study was to identify the existence of industrial clusters within the WA ICT sector. As measured against the most widely accepted definitions of such clusters, no evidence could be found of their existence within the sector, despite the presence of many strong networks. In our examination of the various network layers (e.g. production, resource and social), it was found that the strongest links were across the production layer, with firms focused on securing new contracts and servicing existing ones. Lead customers and key suppliers were extremely valuable to these firms both from the perspective of innovation and financial benefit. The pattern of activity found in the industry survey was replicated within the case studies undertaken for this project.

Overall the picture emerging from this study is of a state ICT sector that has many examples of international best practice and leading-edge research, but an industry that is too fragmented and lacks concentration in either scale or scope. At the industry level WA is a state that appears to offer many comparative advantages (e.g. good lifestyle, proximity to Asia, availability of relatively low cost skilled labour and low costs of land etc), but few clearly identifiable competitive advantages. Apart from the mining and resources sector the state also offers relatively few lead customers against whom small emerging firms can benchmark in order to develop products, skills and managerial competencies.

The Characteristics of Successful Industry Clusters

Analysis of the characteristics found around the world among successful industry clusters suggests that at least eight common features are evident (Rosenfeld, 1997; Isaksen, 1996). In the following sub-sections each of these characteristics is discussed against what has been found within WA through this study.

Concentration into a few specialized industries

First, successful clusters are usually concentrated into a few *specialized* industries that can compete well in international markets. As outlined in this report the WA ICT sector has several areas of specialization that are emerging but continue to support only a relatively few firms and which appear to lack sufficient concentration.

The majority of firms within the WA ICT sector are small to medium with the majority having less than 20 employees. With an estimated total of some 400 mostly small firms, the ability to concentrate the resources of the WA ICT sector into greater areas of specialization becomes important. Although size was not found to be a significant factor in terms of a firm's ability to export or undertake innovative activities, micro-enterprises were more likely to face difficulties achieving successful product innovations than larger firms. Small firms examined in the case study research were also found to experience problems securing tenders and dealing effectively with network relationships that required commitment of additional resources beyond the production network layer.

In general the WA ICT sector lacks sufficient concentration into specialized areas to create the necessary synergies required to promote clustering activity. It is important that future industry development strategies focus on strengthening the existing base of ICT firms, widening and deepening specific industry sub-sectors where there is evidence of international best practice and growth potential.

Possess effective local production networks

A second characteristic of successful clusters is the presence of well-established *local networks* that unite firms' supply chains and production networks for enhanced efficiency and productivity at the production network layer. This study identified some examples of local production networks, particularly where there were lead customers and key suppliers that were locally based. However, a feature of the state's economy is the lack of depth in the industrial base.

Local production networks (LPN) that operate successfully in industry clusters are frequently concentrated around *focal* firms. Such firms are usually large in size and serve as lead customers for smaller supplier firms. The focal firm serves as a strategic centre and generates opportunities for small firms by serving as a lead customer and a generator of innovation within the strategic network that surrounds them (Lorenzoni and Baden-Fuller, 1995).

The main role of the focal firm is to engage in strategic outsourcing, whereby it develops close relationships with suppliers and fosters innovation by sharing ideas and information with its supplier network through collaborative problem solving. Our study found that this process of lead customers driving the process of innovation is taking place within the WA ICT sector. However, many of these relationship remained at arms length (although they were strengthening) and many lead customers were not located in the state. Finally, governments – both federal and state – play a significant role as lead customers and such agencies find it difficult to engage in strategic outsourcing, preferring the arms length relationships inherent in government tendering practices.

One of the key values of strategic outsourcing by focal firms is their ability to build capability within the LPN. There was clear evidence of this taking place in some of the sub-sectors examined by the study (e.g. mining software). This process relates to the interaction between the supplier firms and the lead customers in the development of new products or the enhancement of quality standards. This benchmarking of best practice serves to strengthen the firms in the LPN against competition and should involve a degree of positive rivalry among network players. For WA ICT firms the competition is from outside the state rather than local actors. This is something that was not accepted by all firms, particularly the smaller ones.

Successful focal firms have been found to adopt a *Borrow-Develop-Lend* approach to enhancing their network. By this they scan their environment seeking new ideas and innovations. They then 'borrow' these either via purchase or license and then develop the technology or innovation further to enhance its commercialisation potential. The focal firm then 'lends' this technology or innovation back into the network assisting its diffusion into the market. Although there is evidence of collaborative networking of this kind at the local level there is also a tendency for many firms to resist such activity due to fear of commercial risk or lack of awareness of the opportunities such alliances might yield.

Apart from within government or the mining and resources sector, WA lacks the presence of significant numbers of large focal firms capable of concentrating around them a

production network of smaller firms supplying products and services. Due to the small size of the local WA market, firms seeking growth will look overseas and develop export channels either through alliances with lead customers abroad, or joint ventures with third party providers in other countries. Such internationalisation serves to enhance the international competitiveness of the WA ICT sector, but also appears to potentially isolate these firms from interacting with the local industry as senior management becomes focused on building links with overseas partners.

High levels of innovation

Third, successful clusters have high levels of *innovation* due to the transfer ideas and knowledge. The findings from this study suggest that there is a relatively high level of innovation intensity within WA ICT sector and a strong export orientation among firms. It will be recalled that slightly more than half of all firms were engaged in some form of export activity and an average of 20 percent of gross turnover was being invested within R&D. Such investment in R&D compares favourably with industry averages closer to 3-5 percent of gross turnover. Further, just over half of the firms surveyed did not have a formal or well-defined process of commercialisation although around 55 percent of the firms that had them considered such processes to be effective.

There is little doubt that the WA ICT sector is innovation intensive at the firm level, however, the nature of this innovation activity deserves comment. Joint research initiatives with local, national and international partners, particularly in the area of product development, were reported as taking place by many firms. Much of this activity was occurring within the production networks and was driven by lead customers or senior managers within the ICT firms. There was limited interaction within a research and development context within the resource network. Finally, government policy in the form of assistance schemes (whether federal or state) was viewed with mixed feelings. Survey findings suggested most firms felt more could be done by Governments to assist. From the case study findings there appeared to be dissatisfaction with tendering policy and industry support schemes (e.g. R&D grants).

Active participation of research institutions and universities

Fourth, successful clusters have the active participation of research centres and universities at the resource network layer. As noted previously, the level of collaboration and linkage between firms within the industry and universities or the CSIRO was low. While the general quality of the state's universities and research centres is high, the accessibility of these by local industry, particularly small firms, may be a problem with only 16 percent of firms considering it was easy to access local research centres.

While firms differ on a case-by-case basis, the majority of firms were found to have little or no interaction with universities or research organizations (e.g. CSIRO) or firms in other industries. The level of collaboration with such organizations was found to be weak either within WA or overseas and even extended to the firms located within close proximity to university campuses. Some firms had sub-contracted universities to do 'hard sums', but there was little evidence of substantial joint research projects and interest in this type of activity was being driven primarily by large corporations.

Opening up the interaction between the research centres located in government or universities and the ICT firms, requires attention being given to commercialisation policies within these centres as well as industry support initiatives. For small firms there appears to be a problem accessing such public research centres, and the culture of these centres

is focused heavily on science and technology side of the problem, with insufficient focus on the market or business development side.

Joint research or other collaboration initiatives leading to commercially beneficial outcomes require more attention to be given to business management processes within these centres. While fundamental scientific research is frequently of greater intrinsic interest within academic communities, applied research is of more immediate value to industry, particularly small firms. Despite the investment made by federal and state governments in Cooperative Research Centres, Centres of Excellence and competitive research grants such as the Australian Research Council's Linkage Projects a substantial gap continues to exist between the publicly funded research community and industry.

Possess a skilled and productive workforce

Fifth, successful clusters possess a well-educated, skilled and productive workforce. For many of the large multi-national ICT firms, WA is viewed as a potential source of high quality, relatively low cost, skilled labour with good university programs generating a stream of new graduates. The attractive lifestyle of Perth is another advantage WA has in retaining skilled employees. However, our survey of the ICT sector found that only 36 percent of firms considered that it was easy to access suitably qualified and skilled workers, 38 percent did not feel that they could find such employees and 26 percent were equivocal. Such findings suggest that not all firms are able to find the type of staff that they need and these concerns were not related either to size of firm or industry sub-sector.

In this respect WA should not be complacent about having a sufficiently large labour pool within the ICT sector. Universities and technical colleges need to ensure that their educational programs are producing graduates with the appropriate skills required by local industry. In turn, firms must seek to engage the educational institutions to ensure that their needs are met and that they offer opportunities for new graduates seeking to develop the necessary skills and expertise required by industry.

A further consideration is that the skilled ICT worker of the twenty-first century is generally highly mobile and willing to seek employment opportunities in other states or overseas. Although Perth offers an attractive lifestyle the lack of sufficient concentration of industries within the state may serve as a disincentive to recruitment and retention of capable staff. Where only a few relatively small firms exist in an isolated city such as Perth, the collapse of a single company can leave its employees without any ready alternative options other than a disruptive shift to another state or even overseas.

Finally, our study identified a major problem facing the industry is the ability to find high quality managerial staff. Only 7 percent of surveyed firms considered it was easy to find such management talent, with 65 percent indicating that they saw this issue as a problem. The small scale of the WA ICT sector makes it difficult to concentrate large numbers of managers with deep experience of running companies in this industry. For small firms the cost of hiring and retaining a top-flight manager with international experience is frequently beyond their resources. However, quality managerial capital is as important, perhaps more important, to the successful growth and development of a small firm as financial or venture capital. This is an area only belatedly being addressed by federal government policy, as evidenced by the recent inclusion of management skills development within the Commercialising Emerging Technologies (COMET) program (AusIndustry, 2002).

Presence of competent financial institutions

A sixth characteristic of successful clusters is the presence of *competent financial institutions* comprising banks and venture capital funds that can provide investment capital for growing industries. As noted in this report, there is a perceived lack of venture capital within the state, or at least a perception by many firms that such venture financing sources as do exist locally are difficult to access or do business with.

The WA venture capital sector is small and rather fragmented (Barnett and Mazzarol, 2002). Further, there appears to be a significant gap in the provision of seed capital for early-stage ventures. The BITS initiative in the form of EiR potentially offers access to such funding for WA-based ICT firms, however, there are many micro-enterprises that lack the necessary conditions to qualify for access to this incubator. Alternatively other firms may be too large. Also, as noted in the case study research, not all firms are happy to operate within the managerial frameworks provided by such an incubator.

The lack of access to local sources of venture capital was acknowledged, as a problem for the majority of firms with 60 percent indicating that they did not there was sufficient venture capital in the state to fund their future growth. Difficulties in finding suitable venture capital were a recurring theme in many of the case studies examined for this study. For some the solution appears to have been to seek such funding overseas or at least out of the state. Such overseas venture capital markets were perceived to be more 'mature' and capable of supplying larger sums of money. Senior managers within such firms were usually responsible for identifying this equity financing and secured such funding through their personal or 'social' networks.

A problem with local firms seeking venture capital outside the state is the potential for this to lead to an eventual loss of such firms to the WA economy. While it is not essential that a local firm attracting foreign or interstate investment capital shift its operations away from the state, the risk remains. Larger firms that may seek to shift future production operations and corporate strategic management activities away from Perth readily absorb small firms with commercially attractive intellectual property. Whether or not a firm retains substantial activities in WA is likely to depend on how commercially competitive such activities are.

Close cooperation between firms

Seventh, within successful industry clusters there is usually a *close cooperation* between cluster firms and organizations within other clusters or industries. Such relationships are both formal and informal and frequently operate at the social network layer. While social networks seem to be strong within the ICT sector these are predominately concentrated along the production network. There was little evidence of strong linkages across industries within the resource network.

Our survey found a high proportion of firms considered they were constrained from developing further joint initiatives and alliances due to concerns over the potential loss of control of existing business advantages (46%), or the costs of setting up such alliances (45%). Other constraints recognized by a relatively high proportion of firms were a lack of skills in setting up and managing a partnership (43%); difficulties in locating suitable partners (41%); and managing overseas partnerships (40%). In addition to these survey findings, the case study research found many firms unwilling to collaborate with each other either out of fear of losing commercial advantage, or due to a perception that such collaboration would be unlikely to yield any commercial advantage.

Networks to other knowledgeable milieux

Finally, a further characteristic of successful clusters is their capacity to develop links to other *knowledgeable milieux* in which the social interaction between individuals encourages high levels of innovation. Social networks, while difficult to map, appear to be well developed along the production network of the WA ICT sector, with close relationships being found between the senior management of most firms and lead customers or key suppliers. Such relationships were found to be strengthening over time and are viewed as essential to the firm's business development.

Such social networks were much weaker across the resource network, with ad hoc ties emerging between firms and other industries or organizations able to supply financial, business or research support. More importantly, as discussed, many managers within the industry were reluctant to seek such linkages either out of fear of commercial risk, or more likely a perceived lack of apparent value in pursuing them. Further, the flow of ideas and information for new innovations was passing predominately via the production network rather than the resource network. Our survey found 80 percent of firms were using the Internet and web-based searching as their most important source of information and ideas about new technologies. By comparison only 52 percent of firms considered personal networks an important source of such ideas, and only 45 percent considered formal research to be important. These findings suggest a tendency for the industry to silo into a relatively narrow area of interest that may fail to identify new ideas and opportunities emerging in other sectors.

As discussed in Chapter 4, the creation of a techno-economic network (TEN) structure capable of sustainable generation of commercially valuable products across the science and technology fields and eventually to market requires the penetration of cultural barriers built up between various actors. Overcoming these barriers requires greater attention to be given to the free flow of people and ideas not only along the vertical channel of the production network, but also horizontally across the less travelled ground of the resource network.

Bridging the Investment Gaps

Our analysis of the various sub-sectors within the WA ICT industry suggests industry growth and development requires attention to be given to a series of investment gaps that exist within the local industry. Conceptually these gaps are to be found within the four primary levels of capital:

1) **Innovation Capital** – which refers to the product and process technologies essential to generate something of value and includes the research and development activities conducted within both industry and public research institutions (e.g. CRC, CSIRO, universities);

2) **Market Capital** – which refers to the contracts and customers that will adopt the new products and processes generated from the innovation capital;

3) **Financial Capital** – which refers to the venture funding both debt and equity; and

4) **Strategic Capital** – which refers to the entrepreneurial management that is required to effectively lead the new enterprise through its business development cycle.

Bridging the Innovation Capital Gap

As noted in this study, the industry is investing substantially in R&D and there do exist government initiatives targeting additional funding to support research activities. Despite this there remains a need to bring the otherwise separate worlds of the universities and CSIRO together with industry, particularly small firms. Within the ICT sector the level of investment in R&D in WA is small and fragmented in relation to the concentration of effort taking place within other Australian states (TIAC, 1998). There remains an 'innovation gap' in moving ideas from the realm of the research laboratory into the commercial market place that must be bridged. The future development of innovation capital within WA requires not only an commitment by both industry and government to further investment in R&D, but a drawing together of the scientific and business communities in the state in further joint research initiatives.

Bridging the Market Capital Gap

The small size of WA significantly reduces its level of potential market capital. This requires fast growing small firms to export their products east within national markets, or overseas to international markets. One advantage WA has is its relative proximity to large Asian markets and similar time zone to these same markets. However, the small market and geographic isolation remain challenges for business growth and increase the importance of WA ICT firm's learning how to deal successfully with international markets and develop international business competencies. Further, government tendering policies can also play a significant role in creating or bridging this market capital gap. If such policies are appropriately designed they can serve to widen the market access available to small local firms and provide sufficient business activity to assist these firms to grow large enough to expand internationally.

Bridging the Financial Capital Gap

While the WA venture capital sector is small and somewhat fragmented there are locally based sources of venture capital with sufficient investment funds to assist the growth of the ICT sector. Research into the local venture capital sector suggests that more can be done to unite the various participants in the industry and strengthen the overall levels of education and information flow within the state in relation to venture financing (Barnett and Mazzarol, 2002). The Australian Venture Capital Association Limited (AVCAL) serves as a national peak body for the Australian venture capital industry, and offers a means of addressing gaps in the financial capital gap through reducing the levels of fragmentation in the local industry and enhancing information flows. AVCAL has had a relatively low profile in WA prior to 2003 but this is likely to change.

However, a major cause of firms being unable to secure adequate venture financing is not the absence of such financial capital, but their lack of investment readiness (Ernst & Young, 1997). Too many managers seek financial investment without adequately preparing the firm or its business plan. Commercially attractive technology is important, but investors need to be confident that the management team is capable of delivering on the business plan and need to have clear exit strategies mapped out.

Bridging the Strategic Capital Gap

The ability of a firm to secure financial capital is likely to be contingent on the quality of its managerial or strategic capital. Within WA there is strategic capital gap that is particularly noticeable among the smaller firms. Government policy needs to focus on addressing this

gap with schemes designed to support enhanced management training within the ICT sector, and funding support to enable small firms to secure the services of high quality management personnel.

Recommendations for Future Action

The following recommendations are outlined for shaping future government and industry policy within the WA ICT sector with a view to strengthening linkages and alliances that will enhance the international competitiveness and sustainability of the state's industrial base. These suggestions are also aimed at filling the four investment gaps outlined above.

Identify core competencies and foster greater industry concentration in the search for clusters

While there should be no attempt to 'pick winners', attention should be focused on identifying the specializations within the WA ICT sector that can be enhanced with a view to increasing the overall concentration of industry activity in these sub-sectors. The purpose of such activity is to increase the overall scale and scope of R&D and new venture creation within targeted industry segments. Additional research is required to fully map the core competencies within the state's ICT sector and should focus on generating an audit of products, services and capabilities available within WA and how these benchmark against international best practice. Identifying what is happening within the state's industries and the strength of such relationships enables the identification of emerging clusters.

Create Institutions of Collaboration

A successful strategy within cluster development programs in the United States has been the creation of institutions of collaboration (Porter, 2001). Such organizations are non-government, non-profit entities designed to foster cooperative alliances and joint initiatives within industries with a view to encouraging enhanced networking and clustering. These institutions seek to bring together firms across a range of different industries, as well as universities, research centres and government agencies to enhance collaborative research, commercialisation, market development initiatives or sectoral policy formulation. Their neutral status enables them to avoid the conflicts of interest frequently found between other actors within the industrial market system.

In April 2002 the *Information and Communications Industry Development Forum* was established to provide a communications channel between the industry and government. The purpose of the forum is to advise the Minister on matters such as technology, its application, investment and export in relation to the ICT sector. In addition to this type of advisory group there also needs to be a non-government, not-for-profit entity, that might take the form of a *Western Australian ICT Institute* (WAICTI). Such an institute would be tasked to promote the importance of strategic networking within the industry and seek opportunities for enhanced collaborative alliances leading to new product or market development. This institute would also monitor the overall competitiveness of the sector and provide advice to government on areas of common need. In the area of education and training, the WAICTI would be a useful forum through which universities and technical colleges might interact with industry participants to identify skills gaps for which future courses could be developed to fill. By serving as a focal point for information flow, the WAICTI would be able to facilitate communication between industry and government actors and reduce the tendency to silo.

Identify and nurture 'cluster champions'

Once the existence of internationally competitive industry segments has been mapped, *cluster champions* should be identified and encouraged. Such champions ideally would comprise prominent firms that might include key suppliers or lead customers, willing to provide a leadership role within the industry segment. These champions could serve as focal firms within a local production network, setting benchmarks of performance and guiding future product/market development strategies. Large locally based companies might also play the role of a focal firm, while government agencies could serve as both potential focal firms, and as possible partners in institutes of collaboration. One of the functions of an organization such as the WAICTI would be to identify such champions and assist them to develop commercially useful production or resource networks.

Promote development of themed innovation incubators

In keeping with the need for greater concentration within the local ICT-sector attention should be given to promoting the development of themed innovation incubators. Such incubators would concentrate on assisting the development of specialized technologies and would focus on fostering joint R&D initiatives between local firms. Existing incubator infrastructure, such as found in Tech Park (e.g. EiR), would not be replaced by such activity, but would be complimented by it. An entity such as the proposed WAICTI would assist the formation of themed incubators by identifying areas of common need and research interest and drawing together firms, research centres and other network participants.

Review commercialisation strategies

Further attention needs to be given to the effectiveness of commercialisation strategies within the state's government agencies, universities and federally funded research centres (e.g. CSIRO and CRC). While it is understood that action in these areas is being taken, more can be done to assist the transfer of technology and commercially significant knowledge from the research centres into industry. A stronger alignment of publicly funded ICT research and development to the needs of industry is required. Accessibility to university and other publicly funded research centres for small firms needs to be enhanced.

Foster communities of interest with commercial benefits

Encouraging strategic alliances and future industry clustering requires the creation of communities of interest or social exchange arenas in which actors within the ICT sector can come together for mutual benefit. The reluctance of busy managers to attend seminars and social functions is understandable if these forums do not offer any tangible commercial benefit. Apart from collaboration over research, communities of interest might be fostered around market development activities. A role for the WA State Government would be to arrange for Perth to be the host of international trade fairs targeting the ICT sector. Alternatively the government might provide support to small firms seeking to target such fairs in international markets.

Another possible project around which a community of interest might form is in the provision of enhanced security of IT systems from attack by hackers, viruses or worms. This was a common fear held by many of the case study firms examined during our study. State Government agencies, working in conjunction with local industry and research centres might collaborate to develop protective measures.

Review Government Tendering Policies

The State Government has a significant role to play in the development of the WA ICT sector, as it is both a lead customer and a major competitor in many segments. Overall there is a need for the creation of a coherent industry development strategy or blueprint that seeks to build on existing strengths and encourage enhanced strategic networking both locally and globally. While it should not be the role of government to intervene in the market, the small scale of the WA ICT sector makes the State Government a significant actor. Government contracts provide a large share of the local ICT market place and yet the state tendering policies encourages a bidding war environment that disadvantages smaller firms.

State Government tendering policies should be reviewed to ensure that they do not disadvantage small firms, and that they encourage, rather than discourage, collaborative alliances. The packaging or bundling of tenders to secure economies of scale should be examined to determine whether it disadvantages small firms who may be able to supply parts of a tender solution but not all. In such circumstances strategic networks between suppliers would offer a solution if able to satisfy tender requirements.

Government rules on tendering should be reviewed to allow more flexibility by individual public sector departments and agencies to develop long-term strategic alliances with key suppliers. While there will always be concerns over anti-competitive practices, allowing some flexibility to permit enhanced strategic partnering outside the formal tender system is likely to strengthen local production networks with positive impacts on industry development. Concerns over probity can be addressed by placing constraints on the duration of such agreements and the total expenditure outlay. Transparency and accountability through audit can still be maintained in such relationships.

Review Industry Support Schemes

Industry support programs in the form of research or business development schemes are viewed as too bureaucratic by many firms, particularly micro-enterprises, who frequently require direct assistance in applying for them. There is also a perceived lack of accessibility to government agencies on a personal level with many managers unaware of the person to whom they should contact within government when seeking assistance.

The State Government should consider establishing industry support schemes designed to foster alliance formation with government representatives as focal points. Industry support officers tasked to work via an organization such as the proposed WAICTI or the themed incubators would provide a personal contact within the social network layer, to whom managers could go when seeking to access schemes or identify other resources. Such individuals would be best targeted at assisting the smaller firms, particularly micro-enterprises.

There would also be advantages in the State Government seeking to enhance information flows by organising industry forums, industry exhibitions – as discussed earlier – and disseminating information of common interest to industry participants perhaps via such media as an e-newsletter.

The recently announced Federal Government initiative *ICT Framework for the Future* offers an opportunity for local industry and the State Government to address the long-term needs of innovation and competitiveness within the sector. The steering committee for this review aims to assess the current state of the national ICT sector and identify priority

sub-sectors where world best practice can be fostered to ensure long-term international competitiveness. The State Government of WA should take a leadership role within the state in participating in this review process so as to acknowledge the unique problems facing the state.

Widen technology precinct-cluster area – the Perth ICT Triangle

As discussed in Chapter 10, the existing Tech Park at Bentley, while successful, remains too small in scale to generate a successful industry cluster. Even the creation of the Tech Park Precinct does not provide sufficient scale and scope to produce the type of strategic networks required. An examination of the concentration of ICT firms within the Perth metropolitan area shows a pattern broadly defined by the *Perth ICT Triangle* concept outlined in this report. The Perth CBD and West Perth, Nedlands areas appear to hold the majority of firms, with Herdsman/Osborne Park in close second place. Tech Park, Floreat and the City of Belmont area are also emerging concentrations. A widening of the ICT precinct boundaries would allow the inclusion of multiple universities and research centres, as well as the active support of interested local government administrations.

Business migration and Human Capital

State Government policy should also be configured to align existing business migration programs with the targeting of appropriate human or strategic capital. The attractive lifestyle offered by Perth and the recent downturn in the global ICT industry offers WA an opportunity to target managerial and technical expertise from North America, Europe and Asia to assist the development of the local industry. The business migration program offers a potential vehicle through which overseas managerial expertise and private venture capital could be attracted into the state. Alternatively, experts from leading centres of industry or research should be encouraged to visit Perth as speakers, visitors or on short-term employment contracts. Government assistance could also be provided to firms seeking to bring such individuals to Australia at least on a cost-sharing basis.

Managerial Education and Investment Readiness

There needs to be greater attention given to the development of managerial education for senior managers of ICT firms. This appears to be a particular need among the small firms and micro-enterprises. Such managers may be competent technicians within their respective industry sub-sectors, but may lack skills in the operation of a growing business enterprise. Universities and colleges offer a range of business education programs, but many are difficult to access for busy managers. The development of short course training programs, perhaps in conjunction with organizations such as the Australian Institute of Management (AIM), would help to fill a gap. Such courses should also seek to address the need for firms to become investment ready. This would require attention to be given to the process of commercialisation, venture capital raising and business planning.

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