# HIGH-TECH

# SOUTH AUSTRALIA

## AN EXAMINATION OF THE LOCATIONAL PREFERENCES OF HIGH TECHNOLOGY FIRMS IN THE ELECTRONICS INDUSTRY

by

Mariusz A. Kurgan
B.A. (Hons.)

A thesis submitted for the degree of Master of Arts in Geography

The University of Adelaide

December, 1997

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# ABSTRACT

Using the electronics sector as a case study, this thesis is an attempt to measure the present, and assess the future, importance of high technology industry in South Australia, and to understand both the role it plays in the local economy and the extent to which the industrial environment in South Australia is conducive to the birth and in-migration of high technology firms.

Despite its peripheral location in the Australian space economy, Adelaide is the headquarters of a number of Australian-based high technology companies and is also the Australian headquarters for several multinational high technology firms. Adelaide boasts a quality of life which is the envy of other capitals and indeed it appears that many firm owners establish their businesses (or choose to remain) in Adelaide mainly for that reason, despite the fact that their main markets may be located elsewhere. Firms locating in Adelaide also have access to a skilled and relatively cheap labour force, and with some very specialised exceptions, Adelaide has a good service and technical support network for high technology establishments. There is also evidence that Adelaide is experiencing the beginning of high technology clustering, a process seen by many to be critical in the evolution of a high technology region.

There are however several problems. Adelaide is still relatively isolated from other Australian capitals because of poor air services, some specialised technical personnel need to be 'imported' from interstate or overseas, there is only a small local market, and the links between firms are still immature, with only small numbers

of firms sharing information and working with other firms in the cluster. Academic - high technology industry ties, although fairly common, are rather superficial, and once a project is completed, such ties are generally severed.

Over the years, successive State Governments have tried to address some of these issues. The establishment of Technology Park and later Science Park (both adjacent to universities), the ambitious Multi-Function Polis, the establishment of the Submarine Corporation and the approval for the building of the third runway at Adelaide Airport have all been steps in this direction. If these measures are embraced by industry with enthusiasm, then coupled with the attributes already present, Adelaide certainly seems to be the right place at the right time so far as the development of high technology industry is concerned.

# DECLARATION

I hereby declare that none of the material contained in this thesis has been accepted for the award of any other degree or diploma in any institution and that, to the best of my knowledge and belief, the thesis contains no material previously published or written by another person, except where due reference has been made in the text of the thesis. I consent to this thesis being made available for photocopying and loan, if applicable, and if it is accepted for the award of the degree.

Mariusz A. Kurgan

# ACKNOWLEDGMENTS

My special thanks go to Mr. Hans Wijgh (Business Development Manager, Technology Development Corporation), Mr. Paul Heaft (Investment Manager) and Mr. Jim Manners (Project Officer) at the Economic Development Authority for providing me with invaluable ideas and sources of information at the initial stages of the study. I would also like to thank all the managers/owners and other staff members of the various firms who gave up their time to partake in the questionnaire. Without their co-operation, this study would have been impossible.

I am indebted to my supervisor, Mr. Derek Smith, from the Department of Geography at the University of Adelaide for his time and patience in reading and commenting on countless drafts of this thesis and for his invaluable guidance, advice and moral support. I would also like to thank Professor Graeme Hugo, from the Department of Geography, University of Adelaide, for reading and commenting on the final draft of this thesis, and also Ms. Sue Murray and Ms. Chris Crothers from the Cartography Lab in the Department of Geography for redrawing some maps and diagrams.

This thesis is dedicated to my parents, Jolanta and Antoni Kurgan. My heartfelt thanks are extended to them for their financial and moral support over the past four years. Without the former, the completion of this study would have been difficult, without the latter, impossible.

# 1. INTRODUCTION

> *"New technologies have created the potential to capture, manipulate and process information in ways and time spans that were hitherto impossible."*
>
> (Capello, 1994 p. 193)

Technological innovation is generally acknowledged to play an important role in influencing the path of economic development over time and space. The belief in the latter is exemplified by the fact that throughout the global space economy, nations and regions are competing to create new 'Silicon Valleys', by placing their faith (and taxpayers' money) in high technology to provide a basis for regional prosperity and to revitalise regions whose economic structure has become obsolete.

The Schumpterian view, that ensembles of new technology, if not necessarily high technology, drive the capitalist economy out of its Kondratieff downturns, is widely held. And a strong and dynamic high technology sector tends to be characteristic of strongly growing industrialised economies. However, work at the Massachusetts Institute of Technology, modelling long term business cycles, suggests that the bunched innovations are a consequence rather than a cause of the cycles (EPAC, 1991). Nevertheless, high technology sector products are playing an increasingly important role as inputs to production processes, particularly where major structural adjustment is under way. An internationally competitive local high technology industry will contribute to a more rapid rate of diffusion of new technology through the economy (EPAC, 1991).

While Australia may not have any particular locational advantage in high technology areas, it is a medium-sized and growing advanced economy and seems likely to continue to develop as a competitive supplier at least in some high technology sectors (EPAC, 1991). For example, Australia should be able to establish a comparative advantage in high technology activities related to its primary export sectors, mining and agriculture. Other areas that have been suggested by EPAC (1991) as possible 'winners' for Australia include telecommunications and computer software. A key factor will be Australia's ability to capitalise on demand growth in the Asian region.

High technology is perceived as a rare and precious economic activity, one that is widely assumed to deliver prodigious benefits while imposing almost no costs at all. Most prominent among the benefits claimed for high technology is its ability to create employment out of the depths of a recession. However, it may equally well reduce employment by allowing what has become known as "jobless growth". If firms in established industries seize new technologies with no intention other than to cut labour costs, then high technology may well reduce, rather than increase, overall employment (MacDonald, 1987). This dilemma has characterised many episodes of technological innovation resulting in resistance by the work force as epitomised by the Luddites in 19th Century England.

Another inherent characteristic of high technology is its natural capacity to transmit and process information with greater sensitivity than ever before. This characteristic allows firms to monitor constantly shifts in demand, adjusting output in terms of both quality and quantity. In other words, firms can customise their products based on the *market needs*, bypassing mass production (Capello, 1994).

During the "long boom" which followed the cessation of hostilities in 1945, the Adelaide region became highly reliant on manufacturing industry, for example, automobiles and electrical appliances such as televisions and whitegoods. The 1970s and 1980s saw a downturn in the Kondratieff cycle and the end of the "long-boom", which had been dominated by manufacturing industries. The economy of the Adelaide region went into decline and unemployment increased dramatically. The impact of the downturn in Australia was spatially uneven. South Australia was affected disproportionately compared to other mainland states because of the previous high dependence on manufacturing, which was serving a largely protected domestic market. In addition, some parts of Adelaide's metropolitan area, such as the north western sector, were affected more than others due to their dependence on these manufacturing industries. Such problems were noted in the report published by the Premier's Task Force "IT2000" (1994 p. 8):

> *"In the last twenty years South Australia has seen its traditional economic base in manufacturing gradually eroded by low-cost competition from Asia. A declining population share, consistently higher unemployment than the national average, and an identified drain of skills and expertise interstate and overseas add to the picture of a State urgently in need of a new economic structure."*

South Australia's problems had also been highlighted by the A.D. Little Report (1992 p. ii):

> *"Put simply, South Australia has an outmoded industrial structure that is ill-suited to competition in global markets ... The economic base is very thin and there is little clustering of related firms or industries."*

Successive governments have accepted that a major component of the solution to revive the state's economy is high technology. This is exemplified in the establishment of Technology Park north of the city and Science Park to the south,

and the ambitious plan for a Multi Function Polis rising from the swamps and unemployment of the north western sector of the Metropolitan Area.

> *"To develop, the South Australian IT [Information Technology] industry needs to form significant partnerships with companies that have access to international markets - marrying the local industry's skill and innovation with the marketing expertise of those companies. The industry leader strategy is the key to achieving a 'step increase' in IT-related investment in South Australia by a small number of major international companies.*
>
> *Early investment and development commitments from a few such companies will attract the attention of other investors, rapidly building South Australia's reputation as an IT industry centre and attracting further investment."*
>
> (IT2000, 1994 p. 17)

It is not clear, however, how successful Adelaide will be in attracting high technology industry in the long term, and indeed whether Adelaide will become the 'smart city' of Australia. Furthermore, even if Adelaide is successful in developing a high technology industrial base, there is no guarantee that this alone will restore prosperity in the State.

This study is an attempt to address some of these issues, focusing on the locational behaviour of high technology activities, using the electronics sector as a case study. The study has four major objectives:

1. To examine the structural features of Adelaide's high technology sector. Included here is an examination of the products made by high technology firms and the types of people employed in the local high technology industry.
2. To establish a profile of the types of people who establish high technology firms.
3. To examine the agglomeration economies, clustering and networking of high technology firms in Adelaide.
4. To explore the nature and extent of Adelaide's attractiveness as a location for high technology firms.

Ultimately, the study will attempt to determine if Adelaide is the right place at the right time so far as the development of the region as a high technology industrial district is concerned?

A more detailed statement of objectives, together with the methodology, is presented in Chapter 5. A review of the literature on high technology industries is presented in Chapters 2, 3 and 4, which explore the attempts to define "high technology", the role of technology in cycles of capitalist accumulation and the location of high technology firms in other parts of the world. Chapters 6 through to 11 present the findings of the present study. The concluding discussion in Chapter 12 assesses the implications of these findings for Adelaide.

# 2. WHAT IS HIGH TECHNOLOGY?

> *"High technology is not a particular technique, but rather a form of production and organisation that can affect all spheres of activity by transforming their operation in order to achieve greater productivity or better performance, through increased knowledge of the process itself."*
>
> (Castells, 1985 p. 11)

## 2.1 INTRODUCTION

*High technology* is a phrase which, according to Markusen *et al* (1986), means many different things to different people.

1. *For state and local economic development planners*, it means emerging growth industries that may provide the solution to high unemployment and regional stagnation.
2. *For industry,* it means new products and new, often labour saving, production processes.
3. *For politicians*, it means the promise of rejuvenation of a country's economic edge.
4. *In academia*, it refers to more esoteric forms of research and development.

Therefore, "high technology" has many different roles: to provide jobs in new sectors and activities, to destroy jobs by increasing efficiency, to improve the productivity of the nation's industry, to maintain and protect a nation's economic competitiveness and to produce new, socially useful products and mechanisms, which will raise living standards.

## 2.2 VARYING APPROACHES TO DEFINING *HIGH TECHNOLOGY*

Since there is no direct measure of the degree to which industries are *high technology*, researchers are forced to use surrogate measures, usually provided by government statistical offices. Since these measures are always designed for a different government purpose from that which the researcher seeks, their appropriateness is debatable (Oakey *et al*, 1988).

There are many different approaches to defining 'high technology'. Whilst in some cases the distinction between approaches is very clear, in others however, it is somewhat blurred. What follows is an attempt to classify the approaches to defining 'high technology' according to issues which the definitions are based upon.

### *2.2.1 'Newness'*

In looking for a definition, emphasis can be focused on either the *special* nature of new activities and the types of changes which they engender in society, or on the degree of *rupture* with previous technologies and forms of social and economic organisation which they involve and cause. In the former case, the focus is on the *nature* of the change, in the latter, on the *amount* of change. It therefore poses the question - are the recent upheavals in industrial economies, for example, restructuring, retrenchment and consequently growing unemployment, an expression, to a greater or lesser degree, of the invasion of our societies by particular radically new technologies and activities such as the introduction of robotics or new corporate structures, for example? Certainly, one defining feature of high technology firms could be the degree of upheaval they engender in individual

and collective behaviour, in the sphere of work as well as in daily life (Aydalot & Keeble, 1988).

The term high technology, usually relates to the level of technical sophistication of a product or a sector and the extent to which it embodies the latest technical innovation and utilises leading edge research and development. The term therefore, cuts across industries and sectors, as defined in the ANZSIC for example, and is difficult to define precisely (EPAC, 1991).

One may also find high technology defined in terms of industry growth rates, or on the basis of intuitive, but arbitrary identification of science based, emerging products and processes based on non-routine, state-of-the-art technology. Thus, if there is any essence to high technology, it is surely the *newness* and *difference* brought to products and processes through the application of scientific knowledge (Malecki, 1991).

### *2.2.2 'Industry Structure'*

In their strategy and behaviour, successful high technology firms exhibit a paradoxical combination of continuity and chaos. Continuity is revealed in firms' adherence to a relatively narrow spectrum of products and technologies, whilst at the same time, successful firms are adaptable and able to change fairly rapidly as new technologies and market opportunities present themselves, but only within a cohesive organisation that relies more on communication than on structure (Malecki, 1991). Although even here it is difficult to generalise. Compare for example, the flexible, communications intensive, character of Silicon Valley with the highly structured and relatively inflexible and secretive Route 128 (Saxenian, 1994). The marketing or selling of high technology products also tends to be rather

different compared to other products, whose demand is known or readily estimated. Products need to be tailored to specific customers, or markets may have to be created for new products whose characteristics and advantages are unfamiliar to customers (Malecki, 1991).

### *2.2.3 'Product or Process'*

Attempts to define high technology usually make a distinction between high technology products and high technology processes, that is, between those industries or companies making high technology products and those using high technology products in their production processes. If we consider the 'low technology' equivalents as well, this distinction produces a four part matrix by which we might classify industries or companies:

1. *high technology products and high technology production processes*;
2. *high technology products and low technology production processes;*
3. *low technology products and high technology production processes;*
4. *low technology products and low technology production processes* (Hall *et al*, 1987).

At one extreme in this classification we can consider cases in which the assembly of high technology products such as computers may often be labour intensive and based on 'low technology' production processes. On the other hand, traditional industries may utilise extremely advanced production processes to make traditional low technology products, for example, the automobile and the clothing industries (although the hypercolour T-shirt may well be a very "high tech" piece of clothing).

The other two parts of the matrix may cover those sectors producing high technology goods utilising high technology processes and products, as seems to be the case in parts of the aerospace industry, or low technology goods using low technology processes, such as traditional craft activities. In reality these quadrants have 'fuzzy' boundaries, with a combination of low and high technology products being used in any production process for making high or low technology products.

Another commonly used method of defining high technology industry relates to *inputs* into the activity and two indicators used are *research and development (R & D) intensity*, as measured by, for example, the percentage of turnover expended on research and development and the number of *technical workers*, that is scientists, engineers and technicians, as a percentage of the total work force (Malecki, 1991).

### *2.2.4 'Research and Development Intensity'*

Research and development are an integral part of the overall process of technological innovation, providing the concepts and designs, the materials and components which lead to efficient production of high quality, high technology products (Slatyer, 1991).

Measures of R & D intensity are widely used by policy makers and academics as indicators of the intensity of innovation within a particular industry or country. For example, the OECD (Hughes, 1988) ranks industries by R & D intensity and then splits them into three groups - high, medium and low technology. Interest then frequently centres on how well particular countries are performing in the high technology industries. Policies may be developed to improve or alter the innovative and economic performance of the high technology industries categorised in this

way. The central point is simply that different firms within an industry do not have the same R & D intensity. Consequently, industrial R & D intensity is made up of the differing R & D intensities of those firms that do research and development, and of the sales of those who do not do R & D.

Research and development effort is related to firm and industry characteristics. Firms, of course, differ in many dimensions. Two that have been suggested as important are firm size and firm diversification (Hughes, 1988). If there is some relationship between R & D and firm size and R & D and diversification, then it is, in part, these firm-specific characteristics that are determining firms' R & D intensities and hence an industry's R & D intensity. Thus, the number of diversified firms in an industry and the extent of their diversification may have an important influence on R & D levels (ibid). For example, if diversification has a positive influence on innovative activity, then as firms' diversification varies, R & D intensity will vary. Therefore, whilst a firm's R & D in a particular industry will be affected by the specific characteristics of that industry, it will also be affected by the firm's overall structure, including the nature and extent of its diversification. The observed industry R & D intensity will then be an aggregate of a vast number of firms' different R & D intensities.

McArthur (1990), however, argues that R & D expenditure in a sector is a rather poorer measure of innovative activity or even technological sophistication than is suggested in the high technology literature. First, R & D expenditure and effort are not directly related to returns in terms of innovation or productivity gain (in the same way that GDP is not a good indicator of quality of life). Not only does the cost of development vary from sector to sector according to the technological base, *inter alia*, but it also varies with the degree to which that technological base has

evolved. At certain stages a sector may see a flurry of innovations at relatively low cost after a basic and expensive innovation. Second, measures based on R & D concentrate on the producers rather than on the users of high technology products. The food processing industry and the oil industry are examples of sectors with high levels of process technology, yet below average levels of R & D. Third, R & D is at best an intermediate output in the process of innovation and may be a poor proxy at that. In other words, McArthur (1990) sees R & D expenditure as a measure of the specialisation of innovation based activity rather than of innovativeness *per se*, and one which will over-represent large firms and science based activities at the expense, in particular, of engineering based developments.

Markusen *et al* (1986), refer to three distinct ways in which high technology industries may be studied. First, one can examine the perceived degree of technical sophistication of the product of an industry. Second, the rate of growth in employment within a given sector can be an indicator based on the notion that since high technology industries are anticipated to be rapid net job generators, they can be defined by their performance. By doing so however, one fails to acknowledge other sources of job growth, such as relative price changes, resource exhaustion in one area to the benefit of another, import substitution or successful marketing efforts. The third approach to definition is research and development expenditure as a percentage of sales which they consider to be the most frequent way of defining high technology industries. The *research* component consists of two main elements. *Basic research* refers to scientific exploration for the sake of achieving knowledge. Most of this work is undertaken by scientists within universities and private research institutions. *Applied research* makes up the majority of industrial research and is loosely defined as the application of scientific and technical principles with the

anticipation of returns for the effort. *Development* relates to the processes and products identified in the earlier research phase as having market potential. These are further tested and may eventually become commercial products and processes. Development is usually more costly, risky and time consuming than either basic or applied research, but only because basic research is often financed as a public good.

Conceptually, R & D activity comes close to being a good, quantifiable proxy for technologically sophisticated output. Whilst R & D expenditure serves as a good selection criterion for industries in the early stages of product development, it is less likely to identify the more mature and stable high technology industries. Markusen *et al*, (1986) found this to be a problem for, in their study, petroleum and chemicals fell relatively far down the scale using this criterion. This measure was also found to be additionally misleading for industries such as petroleum, with huge sales figures making up the denominator of the research indicator. It would seem therefore that R & D expenditure, in spite of its popularity, does not provide an accurate definition of what constitutes a high technology industry or firm.

### *2.2.5 'Technical Workers'*

As high technology industries are greatly dependent on highly qualified staff, it would therefore seem that the single most vital input in most high technology firms would be "brain power", as continuing and effective scientific research is essential for competitive success in a technologically dynamic environment (Keeble, 1988). This method of measuring high technology industries probably comes closest to encompassing all the various perceptions of what is high technology. It is closely linked to the sophistication of the product line and the

production process. It may also be assumed that large proportions of scientific personnel imply that innovation is proceeding within the high technology sector, and innovation implies the potential for growth, although innovation may be of the process as well as the product variety.

In an extensive study of the high technology industrial sector in the United States, Markusen *et al* (1986) emphasised inputs and defined high technology industries on the basis of occupational profile, as they believed that conceptually, this definition captures the technical capacity of an industry to harness scientific and technical expertise in the development of new products. They chose the 1980 Occupational Employment Statistics (OES) survey based matrix (a comprehensive source of national industry occupational data), for they found that it provides a better source of occupational data than does the American Census of Population in a number of ways:

1. it surveys employers, whilst the Census allows individuals to select their own occupational category;
2. it uses a more precise schedule of occupations based on skill levels;
3. it uses a more comprehensive and rigorous coding system for specifying occupations within an industry, and
4. it uses a finer disaggregation of industries and of occupations than does the Census.

Using OES data, the authors decided to use occupational mix to identify high technology industries at the national level. Using the occupations of engineers, engineering technicians, computer scientists, scientists (including chemists, geologists, physicists and biological scientists) and mathematicians, the authors calculated them as a percentage of total industrial employment. Once this was

calculated for all manufacturing industries, a national average of 5.82 percent resulted. Therefore, all industries with a higher percentage of the above-mentioned occupations, were deemed to be high technology, all those below, were not. The result was a list of 29 individual high technology industries.

The authors included scientists and mathematicians for they believed that these people are engaged in the conceptualisation and then the development of new products and the development of new materials. Their inclusion however, added a few industries to the high technology list, which, intuitively, were not expected (agricultural chemicals, soap, paints, reclaimed rubber, medical and dental supplies). The list also excludes important service sectors, for example, computer software and commercial R & D laboratories, which are undoubtedly high technology, however, the authors were unable to obtain adequate geographically disaggregated data for those sectors.

### *2.2.6 'Other definitions'*

Some attempts to define high technology are simply a listing of supposed attributes, some of which have already been discussed.

The Australian Department of Science and Technology considers high technology industries to be those:

> *"which indulge in generous research and development spending, in which there is interaction between scientific and technical skills, which generate new products and processes and in which there are entrepreneurs with scientific or technological backgrounds."*
> (MacDonald, 1987 p. 224)

An alternative definition of high technology industries is that:

> *"high technology is high not because it is nearer to God than ordinary technology, but because it involves high risk and possibly high return, a high rate of change and especially, high information intensity."*
> (MacDonald, 1987 p. 224)

A further definition states that high technology industries include:

> *"companies that are engaged in the design, development and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge."*
> (Rees, 1986 pp. 3-4)

The Organisation of Economic Co-operation and Development (OECD) defines high technology industries according to the following criteria:

1. high dependence on a strong technology base and a vigorous research effort;
2. considerable strategic significance for governments;
3. long lead times from basic research to industrial application, short lead times in commercialisation and accelerated obsolescence under the competitive pressures of new product and process introductions;
4. high risks and large capital investments;
5. high degree of international co-operation and competition in R & D production and world-wide marketing (cited in McArthur, 1990).

The difficulty with this sort of "definition" is that it is not a definition at all, but rather a list of characteristics some or all of which high technology activity may have.

The preceding pages have summarised some of the approaches to defining high technology. All of these try to find a definition by examining particular elements in isolation, that is, studying inputs or employment of technical personnel or industry structure. Oakey *et al* (1988) however argue, that any definition of high technology industry should ideally include three measures of innovation: innovation inputs, innovation outputs and measures of industrial growth. The inclusion of all three

measures in constructing a high technology industrial index insures against anomalies produced by any single measure used alone.

*Innovation inputs:* there is a link between high levels of inputs of R & D and subsequent innovation and it is true that substantial innovation is unlikely to occur without such investments. In fact, R & D is itself, a high technology industry.

*Innovation outputs;* their measurement is essential to ensure that the potential suggested by the input measures is related to subsequent performance.

*Growth performance:* in terms of the value of output from industrial sectors, it could be combined with the previous measures to identify the growing high technology industries.

## 2.3 CONCLUSION

The main argument for a universally applicable definition of high technology industry would appear to be that a common 'bench-mark' should be created against which both academics and government planners might assess particular industries in order to measure the extent to which they are truly worthy of the title *high technology*. How can the importance for regional development of high technology industry be assessed and different studies compared, if there is no agreement on what high technology actually means? A universally reliable definition of this type would be of great benefit to all those concerned with the birth, growth and encouragement of high technology industrial expansion.

This review of attempts to define "high technology" has revealed that while high technology is something many national and regional economies are striving to attain, it is not at all clear what "high technology" means, nor is it clear what the net economic and social benefits may be, Thus intuitively, anything to do with

computers or computing would seem to be "high tech". Yet mass production of circuit boards using cheap, unskilled female labour in less developed countries is hardly a "high tech" vision.

Information Technology - IT - must surely be "high tech". The South Australian Government has spent millions of tax payers dollars attracting IT companies to South Australia, companies such as Galaxy, Westpac and Motorola. But what is "high tech" about hundreds of low paid female operators with basic keyboard skills, answering phone enquires and tapping-in information?

High technology can be a product or a process. It can relate to either manufacturing or service activity. In addition why are some areas of agriculture not termed "high tech" if they involve "new" products such as genetically engineered pigs and using inputs and information which have embedded in them considerable research and scientific knowledge. Certainly the mining industry has high technology components, in the exploration stage using remote sensing for example, and the mining operation and initial processing certainly have embedded in them high technology elements.

It begins to appear that perhaps the categorisation "high technology" is not very useful. Most attempts at definition involve lists of attributes not all of which, unfortunately, are necessarily associated with high technology products or processes, and some of which, unfortunately, may be associated with products or processes which would not be considered "high tech".

Perhaps the most useful approach to defining high technology is one which emphasises the quantity of science/knowledge/training embedded in the product or process. This is of course not easy to measure, so that proxies such as the

percentage of scientists employed in the activity, or the funds spent on R & D, are usually used.

There is also the problem of establishing the boundary of the activity for purposes of definition. Thus all would agree that production of genetically engineered pigs or a more powerful computer chip is undoubtedly "high tech". But are the farms which eventually produce the pigs and the factories which make the circuit boards containing the chips high technology businesses?

In the end however, most studies of high technology activities have had to adopt a very pragmatic approach to defining high technology, relating to the purposes of the studies and the kinds of data available. This particular study is no exception.

# 3. THE ROLE OF TECHNOLOGY IN CYCLES OF CAPITALIST ACCUMULATION

## 3.1 INTRODUCTION

The notion of "sunrise" as opposed to "sunset" industries emphasises the cyclical nature of economic development. And yet the concept of *sunrise*, especially as used in a dichotomy with *sunset*, is perhaps an unhelpful way of thinking about industries and of dividing up an economy. Sectors which are labelled sunrise cannot be simply detached from other parts of an economic system. Moreover, thinking in these terms tends to encourage a view of technical change which is focused on products rather than also on changes within the production process. In turn, by doing that, it can lead to a situation where the potential of other sectors, and through that of other areas and regions, is neglected. The textile industry, for example, is usually consigned to the sunset category. Yet recent developments have indicated that the production process even in such an industry can be radically transformed by the application of new forms of technology (Massey *et al*, 1992). In addition, changes in fashion result in a constant stream of new products in an area with such a high income elasticity of demand.

Technology is invariably perceived as central to regional and economic change, job creation and job destruction, the most obvious cause of the cumulative wealth of rich nations and the way to bring the poor nations out of poverty (Castells, 1985). It is important to note that a country can be an efficient user of high technology inputs without producing all these products itself. There is nothing necessarily wrong with importing products and technologies which a country does not produce itself, although clearly there must be sufficient domestic expertise to be

able to use them (EPAC, 1991). However, local products need to be exported to pay for the high technology imports and to maintain a balance of payments, and of course the question of technological dependence and its long term consequences is hotly debated.

The process of organised research and development remains a necessity for firms, regions and nations that aspire to have control over their technological, and thus economic, destinies. For nations and regions, indigenous research and development are essential if local values are to be incorporated in products and processes undertaken there (Malecki, 1991).

The speed of innovations and flexibility of production have resulted in shorter product life spans. Only the most successful products pass from the pilot production line to mass assembly. The goal is to maximise profits using the latest and best ideas and technologies, thereby minimising production costs (Slatyer, 1991).

This chapter will examine the proposition that clusters of technological innovation over time, are causally related to upturns in the capitalist economy, and that the forms of industrial organisation which are presently emerging, generally termed *post-fordist,* are strongly related to these new technologies. The usefulness of the product cycle concept, in relation to high technology industry will then be explored.

## 3.2 HIGH TECHNOLOGY INDUSTRIES - THE FIFTH KONDRATIEFF WAVE?

Capitalist economies everywhere, from the Industrial Revolution onward, have passed through a series of cycles of growth and depression. This

phenomenon was first studied by the Russian economist Nikolai Kondratieff in 1925 (Hall, 1981). Kondratieff observed that capitalist development followed a regular cycle, of about 55 years, from boom to bust and then to boom again. The triggering mechanism, so Kondratieff suggested in a mere sentence, was technological development, which created new economic expansion. But after a time, these industries found their markets saturated, and so recession and then depression ensued, until a new wave of innovation set the whole process off again (Hall, 1985).

It was Joseph Schumpeter in 1939 who, more than any other 20th century economist, attempted to explain the cyclical pattern of economic growth which had been suggested by Kondratieff in his work more than a decade earlier. As interpreted by Schumpeter, each Kondratieff long wave represented a new industrial revolution based on a new group of technologies. The so-called Industrial Revolution was simply the first of these: it was based on Abraham Darby's discovery of smelting iron ore with coal and on the mechanisation of the Lancashire cotton industry, and it ran from the 1780s to the 1840s. The second Kondratieff was the age of steam, railways and Bessemer steel: it ran from 1842 to 1897. The third, the Kondratieff wave of electricity and chemicals and cars, ran from 1897 to 1940. The fourth Kondratieff, based on aerospace technology and electronics started in 1940 and, according to Kondratieff's theory that each cycle should last about 55 years, is probably coming to an end in the mid 1990s (Hall, 1981; Hirst & Zeitlin, 1992).

Each Kondratieff wave ran a regular course. A long climb up from a depression was followed by a fairly sharp slide into another one, though the cycle was complicated by shorter waves (Hall, 1981; Hirst & Zeitlin, 1992). Researchers at the Massachusetts Institute of Technology (MIT) suggest that, during the upswing, dormant basic innovations will attract capital and, via entrepreneurship, begin to

diffuse into economic use. Thus, the MIT researchers do not see technological change as the driving force of the upswing (as suggested by Schumpeter), but rather it is a consequence of investment in new physical capital, which itself will contain many novel features. Rothwell (1982) therefore suggests that the real answer is neither pure technology-push nor pure demand-pull, but rather that a combination of favourable conditions must occur to cause the upswing, in which nevertheless new technology plays a key role.

Hall (1981) believes that there is general consensus among researchers about the nature of the emerging high technology industries on which the next long wave will be based. One, of course, is the microprocessor and the whole range of machines that will incorporate it. A second, is genetic engineering. A third is concerned with new ways of winning raw materials, and all those industries concerned with energy. The new biotechnologies will provide very important auxiliary growth areas and they will ultimately revolutionise agriculture, the food industry and the chemical industry; but the main elements of the new technological paradigm for the fifth Kondratieff upswing cannot come from this source. Still less can nuclear technology play this role. Its applications are extremely limited. Its capital cost is astronomical, so that any large programme would severely aggravate capital shortage problems. Its cost advantages are even now dubious and there are strong environmental, social and political arguments for limiting its diffusion. There are of course innumerable other types of technical change which affect particular processes and products, many of them important for individual industries. Research however, points to the conclusion that the dominant new technological paradigm is associated with the combination of microelectronics, computers,

telecommunications and information technologies. This new paradigm may be loosely described as the information revolution (Freeman, 1986).

To a greater degree than ever before, the innovation of the fifth Kondratieff will come directly from fundamental research advances - so a university link is essential. But also important is the right kind of environment - for the new industries will employ scarce and very valuable researchers, who must be tempted by what the economists like to call psychic income (Hall, 1981).

Although high technology industries have emerged in a totally different environment from their predecessors, they nevertheless do not exist in isolation and are seen by many as the next evolutionary phase of technological development.

## 3.3 THE RISE OF FLEXIBLE PRODUCTION AND HIGH TECHNOLOGY INDUSTRIES

Most of the great technological innovations of the First Industrial Revolution last century were flashes of inventive genius. The inventions were pragmatic. If the first product or process failed to work, it was modified and tried again until a successful configuration was achieved. There was little by way of scientific theory to guide the process or to explain why the final product worked. Once the technological breakthrough was made, the technology was standardised and remained stable for as long as 100 years, as happened in the automotive, electrical equipment, machinery, steel and cement industries (Ansoff, 1987).

During the first 60 years of this century, firms succeeded by optimising the performance of one of their functional areas. Success came to firms that optimised their production efficiently. Such firms became known as 'production oriented'. They have also been called 'production driven', because the power within the firm was

focused on the production function and all other functions were subservient to the needs of production (Ansoff, 1987).

It was also during these 60 years that the Fordist regime of accumulation emerged and flourished (Scott, 1988). Popularised in the United States by Henry Ford himself, it was already part of social scientific and popular consciousness in North America and Europe in the 1920s (Jessop, 1992). Fordism was fully elaborated in the decades after World War II, and encompasses both a characteristic technology and organisation of production, along with the nature of, and mechanisms underlying, consumption at a societal scale. The labour process under Fordism is structured around the semi-automatic assembly line - the familiar standardised mass production operation based on costly fixed purpose machinery. This has given rise to huge productivity gains with accumulation driven primarily by the extraction of relative surplus value. This very productivity itself, however, poses a problem to the system. Mass production must have its counterpart in mass consumption in order to absorb the enormous output of the production system. The possibility for mass consumption arises from a transformation of the conditions of the working class, especially through the institutionalisation of the capital-labour relation in collective bargaining (Schoenberger, 1988).

Fordism's economic strengths are said to have derived from: vertical integration, the detailed division and separation of tasks, machinery dedicated to specific tasks, the full and continuous use of capacity, the rigid codification and hierarchical implementation of work rules and the gradual erosion of skills, job multiplicity and workers' control in the production process. This organisational principle was best equipped to deal with the demands of mass consumption

resulting primarily from the extensive growth in the size, and the expendable income, of the wage-earning class (Amin, 1989).

One of the problems that Fordism helped to resolve was increasing the amount of the working day that was actually spent working. This is partly a question of disciplining the labour force, where possible by regulating the intensity and continuity of the work process via the machinery itself. The problem, however, is also associated with decreasing the amount of necessary down-time associated with start-up and switching between tasks, transfer of materials, retooling and so on. Eventually, however, the increasingly refined technical division of labour within the production process generates a mismatch among cycle times of the various segments of the production process. Production as a whole is, in a sense, regulated by the slowest segment of the work process, which means that some operations, and the workers tied to them, may be temporarily redundant while the rest of the process catches up (Schoenberger, 1988).

Fordism both creates and requires certain characteristic patterns of industry structure and competitive behaviour. Notably, uncontrolled product competition is incompatible with maintaining the mass-consumption base. According to Schoenberger (1988), the system relies on the maintenance of an orderly oligopoly that will support stability in terms of both products and of prices while competition is channelled into such areas as superficial product differentiation, advertising and distribution. The expansion and intensification of international competition based on Fordist production methods, especially where these were not accompanied by the expansion of domestic markets, undermined the principles of competition inherent in the system itself. Mass markets are the precondition for the Fordist organisation of

production. When these markets began to disintegrate, the whole Fordist system of accumulation started to disintegrate with them.

Industry appears to be responding to this crisis through a transformation of competitive strategy in favour of increased flexibility in product offerings and more rapid response to market changes. An effort was made by industry to extract competitive advantage from greater differentiation and destandardisation in the market. The ability to shift the basis of competition from prices and costs of production to product design and performance is not easily achieved, but promises a more durable competitive position (Schoenberger, 1988).

Developing alongside the new Fordist regime of accumulation, was the growth of industrial and corporate research and development, which by the 1930s, had become a major economic activity. During the 1930s, those firms which had the greatest technological capabilities, represented by in-house research and development facilities, were also among the major contractual users of independent research organisations. Firms without in-house research facilities were handicapped in their ability to pursue research and development and technological innovation (Malecki, 1991).

In the 1940s the organisation of industrial research gave rise to a new field of expertise - research management. If science was to be effectively controlled, scientists had to be effectively controlled. The means to such control was the fostering of co-operation among researchers second only to a spirit of loyalty to the corporation. At this time, universities were considered 'knowledge factories' and were called upon to meet the science requirements of modern industry as both suppliers of trained research personnel and as suppliers of applied research (Malecki, 1991).

The 1950s and the 1960s were considered the 'age of big science'. During these two decades, a huge growth occurred in corporate research and development and the distinction and the division of labour between university and industrial research organisation diminished (Malecki, 1991).

For a time the entire Fordist regime and its associated mass production system functioned very well. However, by the early 1970s, the endemic outflow of capital from the core regions was becoming an avalanche, leaving behind large pools of unemployed workers and fiscally crippled municipalities. Competition from Japan and the Newly Industrialising Countries of Hong Kong, Singapore, Taiwan and South Korea became ever more intense and dealt a serious blow to mass production sectors in core regions throughout North America and Western Europe. By the late 1970s, the whole regime of Fordist accumulation, together with its 'welfare state' mode of social regulation was beginning to unwind in significant ways (Scott, 1988).

During this period of the demise of Fordism, the world economy has been subject to persistent and ever deepening crisis tendencies. At the level of the firm, the response to this situation has included the initiation of major processes of organisational and technical restructuring. Now, as in the previous periods of crisis, restructuring is predicated on the search for new bases for capital accumulation (Henderson, 1991).

In the vacuum created by these events, some researchers perceive the outlines of a new alternative regime of accumulation beginning to take shape, at first over the 1960s and 1970s and then more assertively in the late 1970s and 1980s. A number of flexible forms of production have now appeared in all advanced capitalist societies (Henderson, 1991).

Where Fordism called for the separation of conception from execution, the substitution of unskilled for skilled labour and special purpose machines instead of universal ones, flexible production often demands the reverse: collaboration between designers and skilled producers to make a variety of goods with general purpose machines. Employees must posses the readiness and ability to perform a variety of functions, and to acquire new competencies as techniques and products evolve (Hyman, 1988).

Flexible production introduces new actors into the centre of capitalist development, small firms and previously non-industrialised areas. It is also perceived by some to be morally more defensible than Fordism as it is supposed to go some way towards restoring to workers their skills, job-satisfaction, involvement in the decision making process and control over the pace and flow of work. There are two main characteristics which distinguish it from the former Fordist regime. First, a reduction of product, production, transaction and management costs and rigidities as a result of the fragmentation of the technical division of labour among interconnected and task specialised units and firms, that is, a deepening social division of labour. Second, a renewed craft tradition which combines paternalistic and participatory practices with flexible work arrangements reliant upon the use of general purpose machinery, core workers with composite skills and part-time or peripheral workers who are easily expendable, flexible working times and work rhythms. This organisation minimises costs associated with the rigid demarcation of tasks, surveillance, co-ordination, retooling, task committed machinery and so on; and third, the resurgence of regional economies, usually through the build up of a product specialisation by particular areas and the local containment of the various

social, economic and institutional mechanisms enabling further growth in independent firms (Amin, 1989).

The key distinction between flexible technologies and traditional mass production techniques is that what the machine actually does is programmed in via computer software rather than built into the machine at the outset. This means that a given machine can be used in the manufacture of a range of product types and configurations; hence its flexibility in contrast to fixed-purpose dedicated machinery. Significantly, the existence of machines that can perform several functions, or variations of a given function according to product configuration, allows shorter runs and a mix of product types on the line without necessarily sacrificing economies of scale (Schoenberger, 1988).

The essence of flexible competition is flexible and rapid response to changes in the market, whether these result from the behaviour of competitors or from demand shifts. This means that at any given time there must be greater flexibility in the mix and configuration of the products that are actually manufactured than was true under Fordism. It also means that product lines and configurations must be able to evolve rather rapidly (Schoenberger, 1988).

A major shift in the underlying technology of production towards high technology manufacturing processes is also likely to be associated with changes in the technological and social division of labour, including the reorganisation and recomposition of tasks and the elaboration of new relationships among firms. This, argues Schoenberger (1988), seems to be occurring in a way which reinforces the spatial interconnectedness of various elements of the production process, giving new impetus to the process of spatial agglomeration. For example, the implementation of flexible technologies is generally associated with a

reorganisation of the flow of work itself. This is most clearly evident in the move towards 'just-in-time' production which requires a more flexible use of labour on the shop floor. The demand for labour is also likely to shift to different categories of workers. For those workers who remain on the production line 'supervising' the new machinery, a greater flexibility is likely to be required in terms of the number and types of machines that they are able to operate. In addition, demand is likely to expand for various categories of technicians, programmers, and engineers whose skills will be continually called upon to keep the flexible machinery *flexible* in practice.

Traditionally, work was undertaken in two distinct environments: the office and the factory. Today, these definitions have become somewhat blurred. The disintegration of the traditional office has become most apparent in the electronics field, where, in a customer support branch office, one might find product assembly and repair, customer services, training and demonstration as well as the more traditional marketing and administrative office functions (Worthington, 1989).

Flexibility thus entails intensified segmentation within the work force. In the United Kingdom, for example, Hyman (1988) argues that there is a growing dichotomy between the 'sunbelt' (primarily south east England) with highly paid and high-status work in senior corporate management, research and development and advanced technological production and the rest of the country marked either by industrial decline or by the development of low status, expendable production and clerical operations.

This segmentation of the work force, caused by increasing flexibility and the associated emergence of high technology industries, has resulted in the birth of whole regional economies based on flexible production systems, such as Silicon

Valley and Orange County in the United States, The Third Italy, the Southeast of the United Kingdom, and the 'Four Little Tigers', *viz.* Hong Kong, Singapore, Taiwan and South Korea.

> *"The flexible production agglomerations that come into being in this manner are often, in their internal workings, extremely competitive and uncertain places. They usually contain many producers in several different subsectors, linked together in transactional systems that may be subject to rapid and continual change; and their labour markets are invariably quite fluid as a result of limited job security and the ups and downs of production".*
>
> (Scott, 1992b p. 223)

It has been suggested that the introduction of flexible forms of production might be an alternative development strategy for parts of the Third World. Such a strategy might build on existing forms of small-scale enterprise concentrated in the substantial "informal" sectors of many developing economies, and it might also build on the unavoidable flexibility of pre-existing forms of mass production imposed by the constraints of narrow markets and shortages of appropriate skills and materials. Either way, flexible production techniques might offer an attractive route to economic development for such countries in which "modern" forms of industrial organisation could be more easily adapted to local conditions (Hirst & Zeitlin, 1992).

Scott (1992b) points out that flexible production systems have evolved for both low technology and high technology production ensembles. He suggests furniture, publishing and clothing as examples of the former. But there is no doubt that high technology industries seem particularly adapted to these uncertain, rapidly changing and highly flexible environments. High technology industries are, by their very nature, flexible in terms of what they produce and how it is produced. Most contain many small and medium firms, which rely on other firms in a high

technology agglomeration for the supply of inputs. They are frequently engaged in batch production, and due to the *flexible* technology which they employ in product design and manufacture, they are able to change rapidly or alter their products to suit demand.

A significant characteristic of many, if not all high technology industries concerns the changing balance of large and small firms. There is no doubt that many of these industries, such as aerospace and telecommunications, are dominated by large, usually multinational enterprises. The performance, strategies and investment decisions of such large companies are thus of crucial importance for local economies. However, in a number of high technology sectors, over the past decade, a substantial growth has occurred in the numbers and importance of small, usually new, firms and establishments. The new small firms are frequently engaged in research and development or specialised manufacturing; mass production of high technology products being generally the province of large corporations (Keeble, 1988).

After analysing the role of small and medium sized high technology firms in innovation, employment creation and contributions to regional development, Oakey *et al* (1988) came to the following conclusions. First, in the United States smaller firms produced a much higher number of patents per dollar of research and development expenditure than larger firms. Second, small and medium sized manufacturing firms were playing an increasingly important role in innovation in the United Kingdom and had consistently played an important innovative role in the United States. Third, young technology based firms in the United States had played an important role in the creation of new jobs and small, younger firms had played an important employment creating role in the United Kingdom. Fourth, independent

small firms appeared to be more effective vehicles for regional innovation policies and subsequent development than the manufacturing plants of large firms.

There exists a considerable body of evidence to suggest that efficient external communication is a significant factor contributing to successful technological innovation (Oakey *et al*, 1988). Innovation in firms is a process of know-how accumulation, normally based on a complementary mix of in-house research and development and the results of research and development performed elsewhere. One of the factors disadvantaging small firms in their innovative endeavours is that they often lack suitably qualified technical specialists, since they are often unable to support a formal full time research and development effort. This lack of in-house research specialists may also mean that these firms are also constrained in their ability to take advantage of research findings generated outside the firm (Oakey *et al*, 1988).

The small, high technology firm sector is highly heterogeneous and the know-how requirements of small firms will vary considerably depending on the technologies they create and utilise, the rate of technological change in a particular sector and the overall strategy of the firm.

The broadly defined electronics and control instrumentation sectors are areas of high technology production where constantly evolving products and overall growth facilitates the continuing entry of many small firms to fill emerging new production niches. Since the bulk of these evolving product niches are high technology, constant research and development is indicated by the need to keep internal product development at the leading edge of advancing technology. However, so far as birth and early growth are concerned, high technology small firms face problems common to all small firms, and in particular limited financial

resources. The conflict between the need for inevitably expensive R & D and a shortage of investment capital is particularly intense in the small high technology firms, and may result in a defensive, risk minimising, attitude, where an introverted approach to innovation is adopted in which firms move forward incrementally on the basis of internal profits. Despite these problems, the general consensus is that the small high technology firm remains a particularly efficient vehicle for innovation in high technology electronics based industries. Especially advantageous is the informal juxtaposition of production with development which ensures close interaction between concept and construction (Oakey, 1985).

High technology based small firms tend to develop product based technology in order to compete in specific market segments, through the provision of innovative, often custom built, devices. These firms tend to perform some formal in-house research and development since they must be innovative in order to survive in markets where product specifications are constantly changing. Frequently they need technical inputs from external sources to augment their own in-house research and development resources. For an innovative, high technology firm, the development of a new product can be a high risk activity. It demands the commitment of a large proportion of investment funds to a single product, together with the opportunity costs involved in committing scarce resources to one activity rather than another. Anything which can be done to reduce the risk is crucial to high technology small firms with scarce resources. Engaging in external technical and other linkage activities, part of that general process which has come to be called "networking", which can increase the technical, market and managerial knowledge of the small firm clearly can form an important part of its overall innovative activities (Oakey *et al*, 1988).

## 3.4 HIGH TECHNOLOGY INDUSTRIES AND THE PRODUCT CYCLE

While high technology industries tend to differ from other industries in terms of products, production processes, firm size and marketing strategies, their process of evolution though, follows the same pattern as that for non-high technology firms. This process of industrial evolution is generally referred to as the *product cycle.*

The product cycle model proposes that each industrial sector evolves through a cycle of invariant stages. These stages are defined as *innovation, growth* and *maturity.* Increasing outputs in any industry lead to the reorganisation of production through changes in the industry's technology, beginning with skilled, labour intensive methods in the innovation process, evolving through a stage of rapid growth, and concluding with deskilled, capital intensive mass production methods, usually in large branch plants (Scott & Storper, 1987).

The product cycle hypothesis begins with the assumption that the stimulus to innovation is typically provided by some threat or promise in the market. But according to the hypothesis, firms are acutely myopic; their managers tend to be stimulated by the needs and opportunities of the market closest at hand, the home market. The home market in fact, plays a dual role in this hypothesis. Not only is it the source of stimulus for the innovating firm, it is also the preferred location for the actual development of the innovation (Vernon, 1979).

Markusen *et al*, (1986) have proposed a product cycle sequence for high technology industries, comprising *innovation, market penetration, market saturation and rationalisation.* In its earliest stages of development, a new sector is distinguished by its preoccupation with the design and commercialisation of a new product. During the period of *innovation*, firms are directed toward perfecting the

product, which is often customised, produced in small batches and continually redesigned to client specification. A large proportion of the work force consists of engineers, technicians and other specialists. At the same time, commercialisation results in rapid growth of the work force, including management, sales and production workers.

Once a product is fairly well worked out and the result standardised, the major preoccupation of the firm shifts toward mass production and *market penetration*. At this stage, good management and sales personnel become essential and account for a relatively larger share of new employees than at other stages. Growth in output and employment will continue to rise during this period, although at more modest rates than previously. Also, although the sector's organisational build-up will continue to add employment in original centres, a net dispersal of employment will begin overall, as the more standardised portions of the production process are dispersed to lower-cost locations, frequently off-shore to developing countries, while the majority of research and development occurs in "developed" economies.

Once the major markets have been reached, firms settle in to vie for market shares. The main strategy employed by firms during this period of *market saturation* is cost cutting. Firms endeavour to produce their standardised product more cheaply than their rivals, thereby underpricing the competition, and increasing their market share. This is achieved by pursuing economies of scale, purchasing cheaper inputs, cutting transportation costs, adapting process innovations to raise labour productivity and tightening labour discipline. During the period of market saturation, the decentralisation of production will accelerate, especially at the interregional and international levels. Lower labour costs, better business climates

and perhaps proximity to markets will pull the more standardised portions of the production process away from innovation centres.

In the final stage of *rationalisation*, competition drives the price of the product below an acceptable rate of return, due to imports penetrating the regional or national market as new technologies displace the function of the product or because a cheaper substitute commodity serves end users better. Now, the firm's overall strategy will be to diversify out of the product line or to meet importers' lower production costs by overseas relocation. Employment will decrease rather than increase, as layoffs accompany plant closures. This temporal sequence has locational implications which will be considered later.

## 3.5 Conclusion

The development of high technology industries *per se*, is not a totally new phenomenon. High technology industries develop according to the product cycle theory in much the same way as their non-high technology manufacturing counterparts. If Kondratieff is correct, the world economy is about to embark upon a new phase of growth and development. And if Schumpeter is correct, this new upturn will be associated with a new set of technologies and new forms of industrial organisation, which have been outlined in this chapter. But what are the spatial implications of these temporal processes? So far as Adelaide is concerned, the time may be right, but is it possible to generalise about the locational requirements of the emerging new generation of high technology industries?

# 4. THE LOCATION OF HIGH TECHNOLOGY INDUSTRIES

*"Local environments play a major if not determinant role as incubators of innovative activity, as prisms through which stimuli to innovate must pass, as networks of interactions challenging and shaping the imprint of technological change in particular areas."*

(Aydalot and Keeble, 1988 p. 9)

## 4.1 INTRODUCTION

The study of Kondratieff waves and the apparent temporal bunching of innovations have led to conclusions about the occurrence of innovations over time, and consequently opened up the possibility of developing policies to encourage them. Similarly, the study of the locational attributes of high technology regions such as Silicon Valley, Orange County or Route 128 have led to conclusions about the occurrence of high technology over space and again the possibility therefore, of policies to encourage them to develop in other regions.

Throughout the developed world, government officials are actively pursuing high technology development strategies to boost employment levels and to increase the potential for industrial innovation. That competition for high technology is intense and the perceived rewards great, may explain why so many states and regions have redirected economic development policy to encourage it. A desired outcome of these programmes is to alter the existing distribution of high technology industry in favour of particular states and localities (Glasmeier, 1990).

This chapter will briefly present evidence that high technology industry is indeed spatially concentrated. This will be followed by a more detailed exploration

of the locational factors, models and theories which have been proposed to explain these patterns.

## 4.2 Spatial Patterns of High Technology Activity

There is no doubt that high technology activities are distributed very unevenly between and across national economies. Thus in the United States, during the late 1970s and early 1980s, high technology electronics production had become a major specialty of the *sunbelt*, the southeastern and southwestern states of the United States, ranging from Virginia south to Florida and west to California, areas traditionally not associated with industrial development and consequently devoid of the heavy, "smoke-stack" industries of the northern United States. The growth of industry in this region was characterised by two important, but apparently contradictory locational tendencies. First, the electronics industry, together with many other high technology industries has shown a definite tendency toward spatial agglomeration in a series of new growth centres such as Silicon Valley, Orange County and Route 128. These centres often specialised in the production of particular ensembles of high technology outputs, for example computers and semiconductors in Silicon Valley, communications equipment and biomedical equipment in Orange County. Second, considerable locational dispersal of routine production processes has occurred throughout many regions of the United States. The dispersal of routine activities has also involved the shifting of industrial plants to some Third World countries (Scott and Storper, 1987).

Much of the evidence relating to high technology industrial location in the United States has been anecdotal, and it has become "common wisdom" that the South and the West have a disproportionate share of high technology industries

and therefore, high technology employment. On the basis of two measures at least - the location of high technology plants, and the absolute concentration of employment - Glasmeier (1985) notes that the empirical evidence contradicts this popular imagery. She found that high technology plants are found in 80 per cent of U.S. states and that, for example, plants in the communication equipment industry, are found in all 50 states. This dispersion is caused by the spatial distribution of different phases of individual industry product cycles. For example, while research and development and new product development of semi-conductors is indeed concentrated in such states as California, Arizona and New York, assembly operations occur in many states and also in other countries.

In addition, although high technology industries are found in many states, employment is in fact highly concentrated. The Northeast, Middle Atlantic and Great Lakes regions account for 10 of the top 13 states in terms of total high technology plants and employment. States such as California, Illinios, New York, Pennsylvania, Ohio, Texas, New Jersey, Massachusetts, Michigan, Connecticut, Indiana, Wisconsin and Florida, are collectively responsible for 71 per cent of the total high technology employment in the United States (Glasmeier, 1985).

However, as the microelectronics and minicomputer industries have matured, their managers have learned to disperse rather than to concentrate manufacturing growth. Thus, while such major centres of technological innovation will not easily be replicated, the patterns of urban development in Silicon Valley and Route 128 are not unique (Saxenian, 1985).

As manufacturing is increasingly dispersing from Silicon Valley and Route 128, new technology regions are growing. Observers are already predicting the emergence of a "Silicon Desert" in Arizona, a "Silicon Prairie" in Texas and a

"Silicon Mountain" in Colorado. It is, however, highly unlikely that any one region will evolve into an agglomeration of the sort that exists today in Santa Clara County or Massachusetts (Saxenian, 1985).

In the United Kingdom, new high technology growth tended to concentrate in a few areas outside the major industrial regions, notably the belt along the M4 motorway from London to Bristol and the region around Cambridge. Research and development services in the United Kingdom are disproportionately concentrated in the South East (57 per cent of total British employment in research and development in 1976), and have been disproportionately growing there, with 34 per cent growth between 1971 and 1976 against a national expansion of less than 22 per cent. During this time, research and development firms have shown a tendency for movement, but only towards the edges of the traditional heartland. This movement has been led by the large research facilities of multisite companies, requiring good contacts between their laboratories and their headquarter offices, which are themselves tending to disperse outward from London but still within the outer South East (Hall, 1985b).

## 4.3 Factors Influencing the Location of High Technology Industry

Since the 1980s, there has been increasing interest in analysing the distribution, and understanding the locational requirements of, high technology industries. Rees and Stafford (1986) adopted the approach of identifying a number of location variables which they consider to be important influences on the locational behaviour of high technology industries and divided them into two categories:

1. friction of distance variables, which are those that measure the costs of moving materials, products, people or ideas across space. These costs can be measured in terms of kilometres, money, time or even psychologically, by ease or convenience;
2. the second category is concerned with the characteristics or attributes of a given location. Included here are labour, agglomeration economies and infrastructure, power, water and quality of life.

For high technology industries, Rees and Stafford (1986) argue that the attributes of an area are more important than friction of distance, as most high technology products are high value-added components for which transportation charges per unit of value are low, their input materials come from a variety of sources and locations and their markets also tend to be scattered. However, while agreeing that (1) above, is important, it will be suggested later in this chapter that Rees and Stafford's conclusion in relation to (2) is based on a resticted conceptualisation of movement costs and that the friction of distance is indeed a very crucial influence on the location of high technology industry.

This section will proceed by examining in turn each of the factors which have been considered to exert an influence on the location of high technology activities.

### *4.3.1 Labour*

The high technology labour force is characterised by two distinct groups of workers - those involved in the conception, research and development of new products and those involved in the routine assembly of high technology products or components.

A substantial proportion of the labour force is involved in scientific, professional and technical jobs. These are jobs which generally require at least an undergraduate university degree, and very often, advanced graduate training. They are well paid jobs with relatively good working conditions and they are overwhelmingly filled at present, at least in the US context, by white males less than forty-five years old (Weiss, 1983).

Technical workers are among the most mobile segments of the population and they belong to national, and even international, labour markets. Their migration decisions and locational preferences, then, determine to a great extent which places are potential high technology locations (Malecki, 1989). The description of high technology industry as "footloose" is primarily a result of its reliance on flows of people and information, rather than on flows of goods and raw materials. Often neglected in this generalisation is the constraint imposed on corporate location by the preferences of technical workers.

Studies by Oakey *et al* (1988) indicate that skilled white and blue collar workers are key elements in the successful birth and growth of high technology firms. Many high technology large firms in such fields as aircraft production continue to require substantial numbers of white collar research and development and skilled production workers. Consequently, the small firms in high technology industrial agglomerations such as Silicon Valley, are forced to compete with local large high technology firms for the services of such skilled white or blue collar workers. In places of high technology industrial agglomerations, all firms, regardless of their size, are forced to compete for experienced labour and even a large local supply of highly skilled workers may be insufficient to satisfy the large demand. This then causes severe competition in the labour market and

consequently wage inflation (Oakey *et al*, 1988). Much depends, obviously on the rate of growth of the high technology sector and therefore the demand for labour, compared with the supply of appropriate labour either by training or in-migration.

The critically important point here is the fact that research and development workers, like other professionals in short supply, are mobile in the sense that their relative scarcity gives them labour market mobility, but they are in effect, geographically somewhat immobile in that they are willing to live only in distinct types of places (Malecki, 1991): those which offer urban commercial amenities, and the potential for sophisticated leisure and consumption sought by this well-paid mobile segment of the population. Many of these desirable lifestyle attributes are positively correlated with city size. And yet, at the same time, in recent years, there has been an increased demand for other "amenity" values not correlated with city size. These include attractive climate and landscape and seascape, and the opportunity to "get away". The ideal location is probably one which is semi rural, but within an hour's travel of all the functions provided by a major city. Due to the highly 'choosy' nature of qualified personnel, high technology firms are thus drawn to areas with good natural amenities, in particular mild and sunny climates, which offer attractive housing at reasonable prices (Malecki, 1991).

Another characteristic of the labour force in high technology industry which is often overlooked is that a substantial proportion consists of low-paid assembly and clerical work. In addition to poor pay and benefits, these jobs often do not provide very satisfactory working conditions, particularly in the unskilled assembly work. Those hired to perform such jobs are often female and a very large percentage are from ethnic minorities (Malecki, 1989; Glasmeier, 1985).

The high technology labour force also tends to be characterised by low levels of unionisation. This is true of both the highly skilled and the assembly workers. Certainly the lack of any union organisation and representation is one reason why in the United States, clerical and assembly workers' wages and working conditions have not significantly improved during the last decade (Malecki, 1989; Glasmeier, 1985).

High technology firms can and do operate vertically integrated production facilities with technical, production and assembly workers in one location. However increasingly, employers choose to separate technical from non-technical workers. The nature of products and production technologies can also influence the feasibility of a spatial division of labour, thus regulating decentralisation. Case studies of the semiconductor industry indicate that although firms maintain technical activities in core industry centres, production work is often dispersed to satellite centres, and assembly work is shifted to low wage, low skilled locations (Malecki, 1989; Glasmeier, 1985).

Consequently, high technology industries have created their own spatial division of labour. Since few states have large numbers of engineers and engineering technicians, a large proportion of high technology development occurring outside the primary technical centres, consists of branch plants. Little product-related research and development occurs in those outlying facilities, although process research and development has been important in a number of places. Therefore, regions which receive branch plants have experienced low levels of new high technology firm formation.

Regions developing a concentration of high technology employment will also need to develop an employment base of factory or production workers to

produce the developed goods. This has been the case in Silicon Valley, where certain parts of the Valley are home to the R & D technical workers, while others serve as a home to the manufacturing labour force (Saxenian, 1994).

### *4.3.2 Locational Implications of the Product Cycle*

Begg and Cameron (1988) and Glasmeier (1990), suggest that high technology activities can be separated into at least three different stages and that the input, market and location, and consequently labour, requirements for each stage differ. This proposition is also linked to the product cycle idea, which was discussed at length in the preceding chapter.

Begg and Cameron (1988) and Glasmeier (1990) suggest that in the *research and development* phase, the critical requirements are a supply of scientific and technical labour, good communications enabling easy contact to be maintained with other research establishments and sometimes with institutions of higher learning. The typical plant requirements are simple and flexible structures permitting the rapid adjustment of laboratory, office and assembly space. Buildings and the chosen location are expected to project a modern image which corroborates the high technology image of the product being researched.

During the *pre-commercial testing of products*, inputs and perhaps locational requirements change somewhat. Scientific staff are reduced relatively as the demand for technical, engineering, marketing, accounting, legal and computer skills is increased. There is much greater emphasis upon access to potential markets, and a closeness to airport facilities may be a part of this. But proximity to an airport may also be important in that it facilitates face to face interaction between the various specialists who have inputs into the process at this stage. Locational

proximity to the source of critical inputs may also be required, but once again, the image of the area and the building are expected to complement the advanced technical image of the product or process under development. If the company is small, then research and development and pre-commercial testing may be carried out in the same premises. For medium and large companies, pre-testing often occurs at the production plant nearest to the research facility, allowing easy flows of personnel between the units as new product and process variants are tried out, tested and adjusted.

In the *manufacturing and sales* phase, the proportion of skilled and semi-skilled manual labour increases as the proportion of managerial and professional staff falls. The plant size increases, the flexibility of plant structures becomes less important and transport facilities and infrastructure for inputs and outputs become critical elements in profitable production. If the scale of production is small, this phase may be subcontracted to other manufacturers, leaving the high technology company to focus upon research and product or process innovation. In large scale production, this stage is normally undertaken at one of the company's manufacturing plants, which does not necessarily have to be located near the pre-commercial testing plant.

When attempting to explain the importance of labour in the location of high technology firms, it is useful to examine theoretically how a firm's labour requirements change over time, and how this influences firm location. Since the product cycle idea, described in chapter 3, is defined by a sequence of techniques, each with quasi-fixed factor coefficients, it also describes the temporal patterns of change in the industry's locational requirements. As the market grows, routinisation and mechanisation of production alter the industry's labour demand in favour of

increasingly lower skill levels. Scale increases also make possible the standardisation of external linkages, thereby reducing unit spatial transaction costs. As a consequence of these developments, the industry's spatial structure shifts progressively from centralisation and agglomeration to decentralisation and dispersal (Scott and Storper, 1987).

The need for engineers and scientists with the requisite skills causes innovating firms to do their development work in the home market. That requirement, when gauged through the eyes of the typical innovating firm, has tended to rule out sites in most developing countries and has narrowed the choice to some site in the advanced industrial world. Locating in the home market, engineers and scientists can interact with the prospective customers whose needs they hope to satisfy. The propensity to cluster in the home market is fortified by the fact that there are some well recognised economies to be captured by an innovating team that is brought together at a common location. These include the usual advantages that go with subdividing any task among a number of specialists, and the added advantage of maintaining efficiency of communication among the research specialists (Vernon, 1979).

Once the innovator has set up its first production unit in the home market, any demand that may develop in a foreign market would originally be served from the existing production unit. Eventually however, the firm may consider other alternatives, such as that of licensing a foreign producer or of setting up its own producing subsidiary abroad. Although not essential to the product cycle hypothesis, it is commonly assumed that a triggering event is likely to be required before the producer will seriously make the calculations that could lead to the creation of a foreign production facility. The triggering event ordinarily occurs when

the innovator is threatened with losing its monopoly position. In the usual case, rival producers appear prepared to manufacture the product from locations that could undersell the original inventor (Vernon, 1979).

### *4.3.3 Premises and Site*

In a study of 83 pharmaceutical companies (regarded as high technology firms by Haug, 1991; McArthur, 1990; Scott, 1992a) located in the South East, North West, Yorkshire and Humberside in the United Kingdom, Howells (1984) found that the factor most frequently mentioned as influencing the location of research establishments was the availability of suitable premises and site (60.5 per cent). However, obviously, if this were the only factor influencing location then it would be possible to establish Silicon Valleys almost anywhere. Suitable premises and site would seem to be a necessary, but not a sufficient, location factor. Perhaps more significant was the second most important factor, proximity to the company's headquarters.

Haug (1991) carried out a study of 363 high technology firms located in Washington, USA, and found that for all establishments the dominant reason for locating in Washington was that the founder or chief executive officer already lived in Washington and preferred to locate in the state where he/she resided. This was clearly the main reason for small high technology establishments, but was less important for medium and large establishments.This conclusion is however not very useful because it tells us nothing about *why* Washington generates high technology firms and "permits" them to behave in this way; for example, does Wyoming produce as many high potential high technology entrepreneurs, do they want to stay in Wyoming and are they equally successful?

Quality of life attributes, transportation services, utilities and land issues were also important, and it was apparent that the importance of the state's tax climate and pro-business attitude varied significantly depending on firm size. Large high technology firms were found to be far less affected by government policies than their smaller counterparts (Haug, 1991).

As far as the actual premises are concerned, for the majority of high technology firms, one building serves as the headquarters, marketing and sales centre, research and design laboratory and as the production facility and warehouse. Since most high technology firms are very small, they will probably never reach a threshold where commercial success, economies of scale and financial resources permit the separation of production from planning and marketing functions (Markusen *et al*, 1986).

### *4.3.4 Structure of the Firm*

Work by Howells (1984) on high technology firms in the United Kingdom suggests that firm structure affects the locational behaviour of the business. Thus multinational enterprises, in locating their R & D facilities, place great importance on access to international airports. This reflects a desire to facilitate movement of personnel between establishments in different regions or countries.

The results from the survey revealed that the two most important factors deciding the location of R & D were proximity to the company's and/or division's head office and proximity to the main production unit. These two factors together with a third, namely proximity to the sales/marketing department, represented the main locational factors for R & D units in 63 per cent of the companies responding to the survey. Evidence from Howells' study supports the hypothesis that the

dominating influence in determining the location of research and development activities is the relative location of other corporate operations, in particular head office and production activities. Howells (1984) however, does not point out that this can be true only if the headquarters are located in the same country.

### *4.3.5 Academic - High Technology Ties*

Studies in the United States suggest the importance to high technology industries of nearby colleges and universities, especially those which focus on scientific and technical education. These establishments of higher education are directly influential because they are repositories of technical information and they train the needed engineers and technicians. They are also important in attracting and retaining those skilled workers who wish to avail themselves of additional educational opportunities and to upgrade their skills (Rees and Stafford, 1986).

A university, a research laboratory, or a mature technology-oriented corporation appear to be a prerequisite to sustain a concentration of high technology firms. Universities provide local firms with a definite cost advantage in the supply of several critical inputs. Research carried out within the university is a major source of new products and processes and may help solve technical problems for new small firms that do not as yet have their own research facilities. Local universities train many of the scientific, technical and managerial personnel of the firm. In some instances, universities even provide the financial capital required to start up firms. Without such ingredients, the development of a local high technology industry is difficult, if not impossible (Vaughan and Pollard, 1986). Scott (1992b) places great importance on the availability, in a successful high technology cluster, of univesities and other training institutions, because of the problem of

market failure. Individual firms have little incentive to invest in training if the human resources are then attracted elsewhere. Hence the need to provide such training publicly.

Haug (1991) however concluded that except for R & D and biotechnology establishments, proximity to university or educational resources was not a locational determinant, and though large establishments benefited from research activities, educational contacts were primarily for gaining access to information and for having better access to new graduates, who may become potential employees. Haug's conclusion does illustrate a methodological problem. It may well be that access to universities *per se,* is not an important locational factor in the United States, because universities and colleges are ubiquitous. Much more informative would be an inquiry into the actual quantity and quality of high technology - academic ties.

Over the past two decades, industry and higher education have been undergoing a period of significant socioeconomic change with resulting uncertainty. Associated with such changes, both sides have begun to realise that closer interaction between industry and higher education can be beneficial. In the United Kingdom, two basic spheres of industry-academic contact have long been established: the education of personnel for industry and research provision. Polytechnics and technical colleges were set up primarily to act as vocational training centres for industry and commerce, while certain industrial sectors and large firms have been closely involved in higher education research and training. In Britain, such industry-academic links, particularly in research, have been haphazard and there has been little incentive, at least until recently, for higher education to further industrial links. This is now rapidly changing (Howells, 1986).

Furthermore, over this period of rapid technological change, industry has sought closer ties with research expertise in higher education institutions, while becoming more concerned with its educational and training requirements. Simultaneously, higher education has sought closer collaboration with industry, hoping to fill the gap in funding from reductions in university and polytechnic financing from public sources. For some universities in Britain today, finance from industry represents a large proportion of total revenue. Much of the recent interest in industry-academic collaboration has been stimulated by the establishment of science and/or technology parks (Howells, 1986).

Howells (1986) summarised the main characteristics of industry - academic co-operation relating to research and innovation:

1. the type of contact between the two is varied and not unidirectional;
2. the degree of formality in the ties varies, ranging from informal links based in personal ties, through to highly formalised, structured contacts via university consulting groups, such as the Stanford University Industrial Centre or Luminis Pty Ltd at the University of Adelaide;
3. the amount of funds involved varies greatly, depending on the project(s);
4. the outcome of such links ranges from background information through to development work, the generation of an invention leading to a major new product or process and sometimes, associated with this, the formation of a new company to market or produce such an invention;
5. the orientation of industrial-academic ties can range from short run, development work associated with a specific commercial objective, through to long term, basic research which has no immediate commercial application;

6. industry-academic links involve a geographical component or perspective. Links can be local, regional, national or international in nature.

In a nationwide survey of high technology firms in the United States, Malecki and Bradbury (1992) found that the presence of a local university (of any stature) is significant because it allows scientific and technical personnel the opportunity to upgrade their skills and avoid obsolescence. The availability of continuing education programmes are of particular importance to R & D employees and firms, even if the university is not an internationally acclaimed, top-ranking institution. Nevertheless, if a firm is at the "cutting edge" in the technology within which it is operating, it may well be that the kinds of skills upgrading that are required will be available only at particular institutions.

### *4.3.6 Linkages, External Economies and Agglomeration Economies*

As discussed so far in this chapter, much research into the emergence of high technology regions has tried to identify the "critical" factors influencing the location of high technology firms, whether it be labour, or amenity, or business climate or venture capital. As has also been described, the conclusions are sometimes difficult to reconcile, for example the requirement for both highly educated workers *and* blue collar labour, or that high technology seeks out locations in both metropolitan centres with suitable labour, tertiary institutions and other services *and* peripheral regions with no traditions of manufacturing industry and minimal union influence.

Probably the most coherent attempt to explain the evolution of high technology regions, and one which embraces some of the insights of the previous

approaches, is that which stresses the importance of linkages, external economies and agglomeration economies.

Agglomeration economies are of particular importance to high technology firms. This is emphasised by Scott (1993) in his study of the aircraft and parts industrial complex in Southern California. He found that high technology firms required a great amount of *"transactions-intensive"*, face-to-face contact with other manufacturers and suppliers, and that this contact was a two way street, as the suppliers were just as likely to visit the manufacturers, as the latter are to visit one of the suppliers. This *transactions-intensive* nature of high technology firms causes the firms to cluster in agglomerations, and indeed Scott found that agglomeration economies are strongly evident in the Southern Californian aircraft and parts industrial complex.

Such clustering, argues Bibbens (1995), is a valuable tool for short term industrial attraction efforts, and is also useful in strategies to retain firms and extend existing industry clusters. Industrial clustering can also be made the basis for long term efforts to establish new clusters and implement organisational efforts that will pay off over extended periods.

Clusters often emerge and begin to grow naturally, but government at all levels can play a role in reinforcing that growth. Research has proven that programmes to promote industrial clusters, usually in the form of business support services or specialised skill training, are much more effective than sectoral subsidies (Vinde, 1995).

Malecki (1989) suggests that in the United States, high technology industries are likely to be found in states with traditions of innovative manufacturing and within major metropolitan areas, where business services and external

economies of urbanisation, generally, are available. This seems to imply that high technology firms will tend to favour the traditional manufacturing heartland and large metropolitan regions. There seems to be something of a contradiction here between Malecki's (1989) findings and those of other authors, such as Glasmeier (1985) and Hall (1985b), who concluded from their studies that high technology manufacturing tends to seek out peripheral regions. It would seem then that the locational behaviour of high technology firms is still far from completely understood. Perhaps this reflects in part the inability of researchers to define clearly what constitutes "high technology", and the use of highly aggregated data sets. "High technology" may be such a diverse category that seeking general locational laws is pointless. Different high technology sectors may require different explanations.

The size of a state's industrial base and individual metropolitan size are key factors in explaining concentrations of high technology employment according to Malecki (1989). Whatever the initial location, its success in attracting high technology firms is dependent upon several conditions without which dynamic growth will not occur:

1. Information needs compel would-be competitors to cluster closely around the pioneering firms. As changes in the new product and reorganisation of its fabrication and marketing take place on an almost daily basis, word of mouth becomes a primary means of data gathering for key decision makers.
2. As clusters of new productivity emerge, a labour force tailored to the particular needs of that sector begins to form. This is not necessarily an indigenous labour pool, but may be recruited from other areas either directly by rapidly expanding firms or indirectly through the agency of local universities.

3. Members of this newly formed labour force develop an intimate knowledge about the area's firms. Over time, the formation of a highly specialised labour force, composed of professionals and technicians, themselves preoccupied with innovative activities, reinforces the agglomerative tendencies of these industries.
4. Other firms frequently spring up around new high technology centres offering marketing, accounting, consulting and financial services to high technology firms. The growth of this supporting sector in the area's economy in turn reinforces its nodal position. Most small high technology firms therefore, either relocate to, or emerge in, regions which have such support networks in place, as the young entrepreneur often lacks the basic business skills so essential to survival.
5. A final factor in the reinforcement of initial agglomerative tendencies is the willingness of customers to come to the seller in the early stages of a product's development (Markusen *et al*, 1986).

Positive feedback, via linkages, is seen by many (Scott, 1993; Fingleton, 1992) to be the most important explanation for high technology regional development. It implies that the presence of a company at a locality increases the probability that the next firm entering the sector will be located nearby. With a larger number of firms, the probability will be correspondingly higher. Firms are assumed to be spawned from existing firms or from related research-oriented institutions in the area including universities, and government funded research establishments (Fingleton, 1992). Bibbens (1995) adds that efforts to attract firms to a given region are most successful when they rely on the opportunities inherent within existing clusters, and the advantages the region offers to firms similar to those in the industry clusters that already thrive in the region. Such methods are more effective in the short term and more likely to produce lasting results than are attraction efforts

focused on types of firms that are outside the region's existing clusters or that rely on generic charcteristics and expediences such as tax incentives and training subsidies.

In addition, firms from outside the region will be attracted once the region has reached a critical mass. Anderson (1994) argues however, that if a region has a population of less than 500,000 people, a complete cluster is unlikely to exist.

In a study of the Israeli high technology industrial sector it was found that both large and small high technology firms view metropolitan location as being necessary for successful operation. Small plants are often geographically immobile and unable to exercise the option of making strategic location decisions. Instead they find themselves in a location, perhaps spun off from a university or large firm, and decide to produce in that location. The metropolitan location of the small firm thus need not be a conscious strategic choice. For a large operation on the other hand, the high technology production process, with its rapid product life cycles, increasing commitment to research and functionally and spatially discrete stages of production, has resulted in an increasing measure of inter-firm co-operation. As processes become more complex and technologies involve greater specialisation, large organisations have to adapt rapidly to their environments through inter-firm dependencies. This ensures a continuing supply of resources and inputs and can be affected by conscious strategic location decisions, of which the choice of the metropolitan location is but one (Felsenstein and Shachar, 1988).

In the Israeli situation, metropolitan location was found to be directly and positively related to R & D employment intensity and activity and perhaps even a factor in the success of the high technology firm. The metropolitan location is expected to generate an important agglomeration effect for advanced high

technology operations. It provides an important information space and a location for transaction intensive activities, the trading of information and the social control over its use. The metropolitan area's effects seem to be direct and not mediated by the effects of firm age or size. This points to the metropolitan area as a powerful agglomerating force for innovative high technology production (Felsenstein and Shachar, 1988).

Theorists, especially when discussing industrial location on a macro scale, have long stated that high technology firms find is advantageous to be part of an industrial complex, permitting external economies and benefiting all participants by proximity to a common resource pool, particularly labour and new ideas, on which all may draw.

New technology and innovative economic activities display a persistent tendency toward agglomeration and concentration despite numerous efforts at dispersion. The information-intensive nature of technological activities and the resultant need for face to face communication favours places that offer:

1. high levels of competent labour;
2. many fields of academic and cultural activity;
3. excellent possibilities for internal and external communications;
4. widely shared perceptions of unsatisfied needs;
5. a situation of structural instability facilitating a synergistic development (Malecki and Nijkamp, 1988).

Three processes have been emphasised as contributors to the creation of high technology agglomerations:

1. the development of linkages, namely backward (supplier relations), forward (market relations) and horizontal (service sector linkages);

2. the process of new firm formation, which occurs as establishments spin-off from existing high technology firms or from academic institutions;
3. the labour processes within firms producing high technology products (Glasmeier, 1988).

Frequently singled out as the main elements in these agglomeration economies have been the availability of the required labour and access to services. Location within an agglomeration remains attractive for many firms, because essential skills and services are available only within agglomerations and must be accessed to ensure survival of the firm. On the other hand, locating within an agglomeration may cause the firms to incur additional costs - agglomerations may be located in larger cities where the cost of living is higher than in peripheral areas - or other costs such as the necessity of the owner/manager of the high technology firm to move to a larger city, and possibly the loss of what some would perceive as a better quality of life in the periphery, with less congestion, noise and pollution. The production advantages of agglomeration are long standing for technologically sophisticated industries and have been apparent in previous agglomerated urban industries, such as gems and jewellery in the Victorian era (Oakey and Cooper, 1989).

There is a mutual relationship between firms and workers, in that an agglomeration of many firms, and especially of firms in the same or related industries, is an attractive location for technical workers. They have a variety of potential employers should they need to leave their current job. Large cities also provide a larger labour market for spouses in virtually any occupation. Increasingly it is seen to be important for firms to recruit personnel with certain contacts and personal networks in place, to encourage contacts to be formed and maintained

and to circulate people in order to more fully develop their networks of contacts to the advantage of the firm (Malecki, 1989).

In California, Scott (1992a) found that large establishments concentrate for the most part in and around the major high technology centres. Contrary to what might be expected, large establishments are not found on the cheaper land towards the far periphery of the entire urban system, but cluster to a significant degree at polarised locations, which Scott refers to as *Technopoles*. The locational association between large establishments and the main high technology centres suggests that there is a functional link between these establishments and the rest of the production system, which has spatial consequences.

#### 4.3.6.1 Industrial Linkages and their Influence on High Technology Firm Location

Intimately involved in the process of achieving economies of agglomeration are the linkages which firms establish with their environment. These linkages facilitate flows of materials, componentry, products, ideas, information and people. They are traditionally classified as forward, backward or horizontal linkages.

Hagey and Malecki (1986) believe that a key issue for a high technology small firm owner deciding whether to opt for either local linkage economies in a congested and expensive location, or the environmental amenities of a rural location, will be the extent to which the production regime of the firm is indifferent to the benefits afforded by proximity to a high quality and quantity of suppliers of inputs.

Oakey *et al* (1988) argue that input linkages to the production process tend to contribute a facilitative impact on the management of innovation in high technology small firms. The managements of these firms cannot influence the

quality and choice of local input suppliers, but may benefit in their innovation programmes if such facilities are locally available. The presence of a wide range of local inputs, materials, components or services, may be critical for only a few firms, important for most firms and totally insignificant to a further minority of firms. For instance, some high technology firms have chosen a particular location because that region specialises in the production of a particular input which is of great importance to their production. Other firms may simply find it advantageous to have a wide range of input materials on hand, especially if the firms specialise in providing consultancy and high technology design services, so that customers' orders may be filled as quickly as possible. There may also be a small minority of firms which locate in a region to take advantage of the presence of a university or quite possibly specialised labour, however their input materials may be imported from other regions.

In a case study of high technology industries in Florida, USA, Hagey and Malecki (1986) found that the more research and development intensive a plant is, the stronger the local linkages it will have developed. It is commonly thought that especially in plants manufacturing highly specialised products, there is a need for close communication with suppliers, because of the need for highly specialised inputs. From interviews conducted as part of their study, Hagey and Malecki found that two types of communication exist between suppliers and a high technology firm. First, there is daily communication (usually by phone) with suppliers to ensure delivery and to obtain price quotations. This was seen as important for meeting deadlines and bidding for contracts. The second type of communication is technical in nature, often involving the evaluation of a supplier's product or resolving design problems in consultation with a supplier or subcontractor. This communication is

usually interpersonal, often involving the technical personnel of buying and supplying firms and frequently requiring travel for 'face to face' or 'hands on' consultation.

It was also found that one of the greatest differences in local linkages between high and low technology plants is that for skilled labour input. Plants with high research and development expenditures utilise locally available supplies of degreed scientists and engineers to a much greater extent than do low technology firms. Furthermore, local establishments with many scientists and engineers and plants performing research and development are more likely to hire degreed technical personnel from within Florida, than plants which only employ a few scientists or engineers and/or which perform limited research and development, if any. As plants get bigger, they tend to tap more non-local supplies of skilled labour.

Unlike input linkages, where the flexibility of firms to source material substantially depends on availability factors beyond their control, output or sales linkages are largely the tangible evidence of a firm's management success. Oakey *et al* (1988) argue that in many cases, a formal marketing strategy for high technology products does not exist and sales depend on a minimum amount of advertising and the passing on of news regarding a new product by word of mouth from one satisfied customer to another. Obviously, not all high technology firms produce and market a final product. Indeed, some firms may produce only products which are then purchased by other high technology firms and incorporated into a final product. The examination of sales linkages is extremely important, because of the significance of marketing to overall success in the firm.

Research by Oakey *et al* (1988) also suggests that high technology firms are generally poor performers when it comes to extracting full value from expensive

research and development and production work. In general, high technology small firms prefer to maintain a large number of customers rather than become dependent on a single customer who could suddenly cease to purchase the firm's output. The withdrawal of a single major customer may be devastating to high technology small firms and may cause a 'domino effect', in which closures ripple backward along chains of production as orders are cancelled and outstanding debts are not paid. In a number of instances, the general desire for a wide spread of customers may be impractical as some high technology small firms may produce goods or services that are useable only by a limited number of purchasers, for example, aircraft parts and telephone equipment, or goods may be custom-made to a buyer's particular specifications.

The characteristics of the firms located within a given region also affect the types of linkages which will develop within that region. From their own research, Hagey and Malecki (1986) have found that few local linkages take place from large establishments, from branch plants with minimal autonomy and from plants which have recently relocated from another region. They believe that firms which produce technologically advanced products require more specialised inputs than are utilised by other manufacturers. As few regions can provide such inputs, even small high technology firms often must purchase from non-local sources.

Agglomeration economies are a powerful factor in the location of military oriented manufacturing. These agglomerations may be of two types. First, defence oriented production locates in close proximity to existing military bases, as the experimental nature of the product may require collaboration between personnel and producers. Second, military bases may provide a regular stream of trained, specialised workers taken out of short and medium term service. They may also

provide free infrastructure to firms producing nearby. Government facilities of other types may also serve as magnets for military oriented production. In the United States, the location of government research and development laboratories is significantly more skewed toward the South and the West than is private corporate research and development. Much of this research and development is military oriented and commercial spin-offs or suppliers may locate nearby (Markusen and Bloch, 1985).

Many of the great expectations of 'growth centres' rested on the assumption that linkages from local firms would remain largely local. Instead, many linkage flows were found to benefit either other firms elsewhere or other establishments within a multi-locational organisation. It is believed that the most propulsive industries and the most innovative firms are those which are most likely to have widespread, rather than local, linkages because they use specialised inputs that are not available in all urban areas. Although linked industries often tend to be found close together, not all or even most establishments locate in a particular area in an attempt to maximise local linkages (Hagey and Malecki, 1986).

## *4.3.7Government Influences*

### 4.3.7.1 Influence of Government Policies

Given that clusters of technological innovations do indeed play an important role in stimulating economic development at particular points in the economic cycle, it is not surprising that governments have been active in trying to promote the circumstances which will foster R & D and innovation. Increasingly, technology is being regarded as the "social pool of the industrial arts" (Thomas, 1975, p. 4).

Factors which have been proposed as important determinants of a region's innovative performance are (Camilleri *et al*, 1987):

1. the scientific education and research base of the economy determines whether a region has the required skills and capabilities to produce technologically complex products;
2. the level and intensity of competition determines whether firms have the incentive to seek and engage in production of new products;
3. the size of the domestic market and access to export markets establish the demand conditions for new products or services.

Governments have been involved in attempting to influence the socioeconomic environment in order to promote these conditions and thus the development of new, usually high technology, firms. Given the *clean* office and research atmosphere of research and development activities, many of them have been attracted to the office and industrial parks that have been "sprouting up" in and around most metropolitan areas. As a response to this phenomenon, governments have established science and technology parks to cater for the preference of high technology firms for a campus like setting, with low density, dispersed building sites. Many countries or regions aim at improving their creative infrastructure by establishing information centres such as technology or science parks. These provide a geographical concentration of communication, knowledge and research infrastructure, which is aimed at transferring new results from scientific research to users in the industrial or commercial sector (Malecki and Nijkamp, 1988). In addition, governments have established incubator facilities to address the specific problems faced by new firms. Incubators may range from inner-city buildings to commercial facilities in science parks and offer shared services, advice, financing

and other help to emerging high technology firms. The attraction of the shared facilities to new firms is that they can significantly reduce the initial capital needed to establish the business and they can also give small firms better access to information networks, which could prove to be difficult for individual firms (Malecki and Nijkamp, 1988).

Most regional programmes for high technology development in the United States are considered as extensions of existing state level economic development strategies, usually by targeting industrial recruitment and incentives offered toward high technology industries. The high degree of competition between high technology regions, the lack of adequate venture capital in some cases and the increase in congestion in such areas have in several circumstances prevented the emergence of substantial spin-offs for the region itself and its surroundings (Malecki and Nijkamp, 1988).

Increased funding levels at state supported universities is a relatively easy way for governments to improve the high technology status of a region; less frequently is any comparison made with universities or regions elsewhere. Too much cannot be expected from such policies. Unless there are suitable job opportunities within the region, graduates will go elsewhere; their return could be encouraged by desirable employment, but this requires a more diverse and long term set of high technology policies. University research must be prominent in both quality and quantity to attract a cluster of research and development facilities. It is neither easy not cheap to create and maintain the status of a top ranking university. Regions with several top ranking universities, especially if located close to major metropolitan areas, can attract both government and industrial research and development (Malecki and Nijkamp, 1988).

The development of high technology industries can have significant indirect effects on the level of employment. For every job created as a result of investment in a new industry, there are others likely to be created in industries supplying a wide range of products and services for the new firm, not all of which will be themselves high-tech. Furthermore, to the extent that new high technology industries help diminish the balance of payments constraint, they help to increase the growth potential of the domestic market (Camilleri *et al*, 1987).

#### 4.3.7.2 Government Defence Expenditure

Defence spending by governments constitutes an important factor in high technology industry's location. Since World War II, high levels of defence spending have been key to the development of science based industries in many regions. Departments of Defence in most countries, serve both as a major source of research and development funding and the market for resulting high technology products, and typically areas that are awarded high levels of defence spending also gain large numbers of high technology jobs (Glasmeier, 1990), for as one would expect, military equipment, weapons and transport are very much high-tech in nature. In the United States for example, Cold War rivalries resulted in continual innovation in weaponry and delivery systems and defence systems.

The goal of military research and development is to make the product of the opposition ineffective, and the result of international competition of this sort, particularly between the former U.S.S.R. and the United States, has been the creation of a dynamic, whereby existing products are rapidly rendered obsolete. The nature of the military product and its production process is also quite distinct from commercial manufacturing. The units of output of assembled weapons,

equipment and transport systems are often few in number and highly sophisticated in nature (Markusen and Bloch, 1985).

Although military-oriented manufacturing is often considered high technology, it is expected that those high technology firms that engage in military contracting will tend to be involved in less research intensive activity than civilian high technology in general. Military contracting is further predicted to be positively related to larger and older firms due to the oligopolistic structure of the military market. Military contractors are also likely to be older than the average civilian high technology operation often having arrived at technological production through product diversification, for example, the progression from production based military precision equipment to production based on the military applications of electro optics (Felsenstein and Shachar, 1988).

The most dominant element in the development of Israel's high technology industry, for example, has been the expansion of indigenous defence capacity. Since the 1967 Six-Day War, the local military industry has grown from a base of low technology, labour intensive production using imported technology into a technologically sophisticated military industrial complex. Although military industry as a precursor to high technology industry is a universal phenomenon with examples available from many countries, the Israeli situation is unique, as the government commits over 25 per cent of the country's GNP to this purpose, compared with 0.84 per cent in the United States and 0.53 per cent in the United Kingdom in 1988 (Felsenstein and Shachar, 1988).

The defence influence is also responsible for the sectoral composition of Israel's high technology. An estimated mere 9 per cent of employment and 19 per cent of high technology firms are in those sectors such as chemical,

pharmaceuticals, biotechnology and agro-technology that are outside the electronics/communications equipment/aeronautics nexus that has formed the mainstay of advanced military production. A further feature unique to Israeli high technology relates to the role of foreign owned firms. While public policy has actively tried to encourage direct foreign multinational investment in high technology industries, the extent of this involvement remains limited. Foreign owned companies are estimated to account for only one per cent of total employment in Israel as compared, for example, with 33 per cent for Belgium and 19 per cent for Scotland (Felsenstein and Shachar, 1988).

In many regions, there is a strong link between defence spending and the successful establishment of a high technology sector. Upon investigating studies by the United States Bureau of Industrial Economics, Markusen and Bloch (1985) found that in 1983 the United States' defence industrial base consisted of 58 sectors, almost all of which were manufacturing activities. Almost all fall into the high technology category, with their recent employment levels, defence market shares and expected defence related output growth rates.

The defence build-up of the late 1970s and the 1980s has thus had distinct spatial patterns influencing the pattern of economic activity, benefiting some areas of the country, whilst hurting others. In fact, defence spending is more concentrated spatially than most other types of government spending (Atkinson, 1993). As a result, cuts in defence spending will work their way through the economy unevenly, affecting some states and communities significantly more than others. For example, California is home to 11.7 percent of the United States work force, yet it receives over 19 percent of defence spending (Atkinson, 1993). Such defence spending cuts will have a direct impact on the many high technology firms which are dependent

on defence contracts for their livelihood. However the effect of this on technological innovation in urban areas hit by defence spending cuts, and on their ability to continue to generate new cycles of economic activity is still somewhat of a mystery.

#### 4.3.7.3 Role of Technology Parks

Technology Parks or Science Parks are government initiated attempts to foster high technology industry. Their logical basis is the conventional locational wisdom which has been described in this chapter. In particular they assume that links to scientific institutions are important, that agglomeration economies are important and that attractive environments and working conditions are important for the high technology work force.

By definition, a Science Park is a property based initiative which has formal operational links with a university or other higher educational or research institute, is designed to encourage the formation and growth of knowledge based businesses and other organisations normally resident on site and has a management function which is actively engaged in the transfer of technology and business skills to the organisations on site. Science Parks bring together many high technology firms, frequently working in related fields of research or technological development. Many firms choose to locate on such parks primarily for the agglomerative advantages and the ability to form linkages with other park firms (Massey *et al*, 1992).

The term Science Park and concept originated in the United States as a result of developments around Stanford University. A Science Park is essentially the creation of an attractive landscape setting for high quality industrial buildings at low site densities, designed to accommodate companies involved in research and

development in new technologies and in manufacturing or production systems, which depend on the application of new technologies (Brook, 1982).

Science Parks bring together and interrelate particular ideologies and practices of scientific advance and industrial innovation, divisions of labour within society and their related social structure and the geography of social and economic development (Massey *et al*, 1992).

Land within a Science Park is generally reserved for:

1. industries closely related to the work of the university which have a high research and design content and which are likely to use the existing or proposed facilities of the university;
2. industries where the initial components are so closely interdependent that they require control by the same executive personnel throughout the entire process;
3. industries which include those processes which precede the manufacturing stages and are activities which are relevant to a continuum of research design and development leading to manufacturing and marketing, but do not involve either high tonnage productions, but which employ labour consisting of a high proportion of scientists, technologists, technicians and skilled craftsmen (Brook, 1982).

Certain reasons for establishing Science Parks constantly recur. These are that Science Parks will promote the formation of new firms; they will facilitate links between the host academic institutions and park firms and thus improve the take-up of ideas and their development into new products and processes; firms on the parks will have a high level of technology and be "at the leading edge" - they promise a 'sunrise' future, in many areas to replace the existing 'sunset' local economy and

they will create employment opportunities. These are the assumed potential effects of setting up a science park (Massey *et al*, 1992).

Science parks however, also have an indirect effect on the location of high technology industries. The Research Triangle Park in North Carolina, provides just such an example. Regulations restrict what can be done on the park. Companies can put things together on a limited scale, but they cannot set up a fully fledged factory. They can build offices, but only to run their research and development. Due to such restrictions, many companies have established their factories within an hour's drive of the triangle in order to take advantage of agglomeration economies. These include Abbott Laboratories, Burroughs, Wellcome, Glaxo, Texas Instruments and Hewlett Packard (Kenward, 1989). If a Science Park is to be successful and attract tenants which are wholly involved in high technology processes then the authority must clearly set out the types of use it is willing to accept on the site and be prepared to hold land and buildings vacant to attract these tenants. Clearly the situation is helped if the local authority owns a suitable site, as this significantly reduces the financial outlay put at risk. If a developer and funding agency can also be encouraged to build advance units the risk capital expended by the authority is further reduced (Brook, 1982).

The encouragement of small, high technology firms to locate within specially constructed science parks on the edges of the heartland would offer a number of advantages over traditional industrial areas. The presence of these new high technology forms of production would offer employment in occupations commonly found only in the heartland, and would diversify the local industrial base. These new jobs would be created in dynamic industries where employment would be likely to grow. Furthermore, the supposedly clean nature of high technology

production would ensure that there would be very little environmental damage caused by the establishment of a high technology science park in areas of high natural amenity (Oakey and Cooper, 1989). Science parks are thus in large part based on the premise that they provide a spatial focus for university-industry linkage, technology transfer and the application of university research to commercial needs.

## 4.4 CONCLUSION

High technology is a fundamental and pervasive variable in the world economy, with impacts in the workplace, on local areas, on firms and on national prosperity. It is not however, an easy task to identify precisely its distinguishing characteristics, its locations or its effects. As this chapter has revealed, there is no consensus in the literature concerning the locational requirements of high technology industry. In fact, much of the empirical work, and the attempts to theorise which arise from this empirical work, are to say the least inconclusive and at worst contradictory.

It seems that theorising about the location of high technology industry at present says more about where it does not want to locate, rather than where it does.

> *"... the new industry is likely to be found in regions and in areas quite different from the old. Indeed, the image of the old industrial city - committed to dying industries produced by traditional methods with an ageing work force resistant to change, with a depressing physical environment that is unattractive to mobile workers, and perhaps lacking the necessary research expertise in the new technologies - is just about as repellent to the new industries as could be imagined. The new industry, then, will seek positively to avoid such places..."* (Hall, 1985b, p. 14)

Nevertheless, this review of the literature on the location of high technology industries suggests that what is locationally important will be affected by the size and structure of the firm. Furthermore, it suggests a number of important influences on the location of high technology firms, in particular labour, defence expenditure

and academia. But perhaps above all, linkages and related economies of scale and scope, all summed up in the term agglomeration economies, appear to be very important.

Few attempts have been made, though, to link the growing body of evidence on these new forms of production to existing location theory. This is surprising, since an examination of any of the new high technology industrial concentrations suggests a number of features that resemble previous industrial agglomerations, thus implying the relevance of earlier location theories (Oakey and Cooper, 1989). It could be argued that no fundamental alteration to existing industrial location theory is needed to accommodate the spatial search and decision processes of high technology plants, nor in explaining the birth places of new high technology firms. High technology firms appear to place greater emphasis on spatial variables, rather than on the costs of moving materials to the plant or products to the customers. However, another kind of movement, the movement of information is undoubtedly a very important locational factor. Consequently, awareness and consideration of the specific concerns of existing activities within an area are important since high technology growth appears to be a localised circular and cumulative process (Rees and Stafford, 1986). The high technology Meccas of Silicon Valley and Route 128 both grew out of an historically unique conjunction of political, economic and institutional circumstances. The origins of these seed-beds of technology based industry lie in World War II, in the spending priorities of the Cold War, and in the development of close links between federal funding sources, local academic institutions and local industry. It is unlikely that this particular combination of circumstances will be repeated. This study was stimulated by questions relating to Adelaide's high tech future, and to this issue it now returns.

# 5. OBJECTIVES AND METHODOLOGY

Following the decline of its traditional industrial base, South Australia has embarked upon a programme of restructuring in which high technology plays a crucial role. High Technology industries however, are not a new phenomenon in Adelaide. The Weapons Research Establishment was located here in the immediate post war years. More recently the decision was made to establish the ambitious Multi-Function Polis north-west of the city and to construct a new generation of high technology submarines at Port Adelaide. The present government is aggressively promoting Adelaide as a centre for Information Technology.

Previous chapters have attempted to define high technology and have explored the literature which seeks to explain the cyclical nature of high technology innovation and its locational characteristics.

The aims of this chapter are twofold. First, to outline the objectives of the present study and how they relate to the literature which has been reviewed. Second, to discuss the methodology which was used by the author to determine which high technology firms would be examined, and then to outline how the data pertaining to individual firms was collected and assessed.

The main purpose of this thesis, and the concern of the following chapters, is to apply these ideas to the Adelaide Region, to discover whether Adelaide is indeed the right place at the right time for this high technology development strategy.

## 5.1 OBJECTIVES OF THE STUDY

The first objective of the study is to examine the structural features of Adelaide's high technology sector, which the literature review has suggested are important to the success of any high technology region. In attempting to examine these structural features, a number of factors will be assessed. First, the study will attempt to determine the size and ownership of Adelaide's high technology firms to determine whether Adelaide has a 'central' or 'peripheral branch plant' economy and whether it is characterised by a large number of small and medium high technology firms which the literature review has suggested are dynamic and flexible.

A second factor which will be assessed is the spatial pattern/distribution of Adelaide's high technology firms to see if there is any evidence of the clustering, which given the technical and social division of labour, is necessary in order for small and medium establishments to achieve the agglomeration economies and synergies which they require.

The production profile of the Adelaide region will then be assessed to determine what the region produces, and in particular to what extent the output is directed towards final demand or towards other producers in the form of intermediate products. This aspect is clearly related to linkages and clustering which will be dealt with later.

Finally, an assessment will be made of the employment profile of high technology firms within the Adelaide Region, because the availability of suitable labour is invariably seen as a major factor in the evolution of high technology regions, and the local skill base is also often related to the development of entrepreneurship and new firm start-ups.

The second objective of the study is to establish a profile of the types of people who have created the high technology firms in Adelaide. Included here will be an assessment of their educational background, previous work experiences and what motivated them to establish a high technology firm. The study focuses on single-establishment firms only. Due to the difficulty of talking to owners/founders of multi-establishment, and in some cases multinational firms, (either located interstate or overseas), this subgroup has been omitted. In order to prevent bias in the findings, the multi-establishment firms located in Adelaide have also been omitted.

The third major objective concerns agglomeration economies, clustering and networking. All of these are repeatedly seen by many authors (Bibbens, 1995; Felsenstein and Shachar, 1988; Fingleton, 1992; Malecki, 1989; Scott, 1993; Vinde, 1995) as being important processes in a dynamic high technology region. Chapters 8 and 9 therefore, explore the backward and forward linkages of Adelaide's high technology firms.

Backward linkages are concerned with a firm's relationship with its suppliers. Chapter 8 examines the location of the suppliers, whether they are local, interstate or overseas. Much has been said in the literature (Rees & Stafford, 1986; Vaughan & Pollard, 1986; Howells, 1986) about the importance of high technology/tertiary academic links. The quantity and nature of these links will therefore be assessed. Finally, since the immediate availability of inputs to high technology firms is extremely important, an assessment will be made of how easily high technology firms in the Adelaide Region access their inputs, whether there are any difficulties and, if so, what effect do they have on performance.

Forward linkages, discussed in Chapter 9, are those which are concerned with a firm's customers and the firm's marketing strategies. A major factor which will

be examined here is the extent to which firms make intermediate products, which imply forward linkages with other firms. The chapter will examine whether Adelaide's high technology firms concentrate on making products destined for final demand, and if so, where are these forward linkages directed - to local, interstate or overseas markets? The chapter will also examine how flexible are Adelaide's high technology firms in relation to customer demand.

A further objective of the study is to explore the degree to which the Adelaide Region is, or is not, attractive as a location for high technology firms and what are the perceived advantages and disadvantages of Adelaide as a location for high technology establishments. This is approached at two levels. The first, or macro level, is concerned with assessing the Adelaide region as a whole, whilst the second, at a micro scale, looks at the locational preferences of high technology firms within the Adelaide Region. In addition, special attention will be paid to the attitudes of firms located within Technology Park and also to how Technology Park is seen as a potential location by firms located elsewhere.

The literature review suggests that high technology clusters gain from the presence of firms which supply necessary components or services, though they themselves do not manufacture their inputs. And of course, as a cluster evolves, it becomes more attractive as a location for suppliers. The final objective of the thesis therefore, is to examine briefly the role and importance to the Adelaide high technology industry of firms which function as suppliers, rather than manufacturers of componentry, and the relationship which these firms have with their customers.

On the basis of the evidence collected from the survey, the thesis will conclude by attempting to assess to what extent the Adelaide Region is indeed in the process of developing as a dynamic high technology industrial district.

Hopefully too, it might suggest some policy directions which will nurture and promote the sector.

## 5.2 METHODOLOGY

As part of the process of establishing the context for high technology industry in South Australia, contact was made with a number of organisations, which were thought would be able to assist particularly in the initial definition of what constituted a 'high technology' firm and the high technology sector, and perhaps in establishing a database from which a sample of high technology businesses could be selected for close study.

Initial contact with the South Australian Economic Development Authority was not immediately fruitful and it was suggested that the Technology Development Corporation at Technology Park might be able to provide more information.

Innovation Management, a division of the Technology Development Corporation (now the Multi-Function Polis Board), was contacted by telephone. Innovation Management sent out an information package mainly describing how potential entrepreneurs should go about starting a new high technology firm, and also some of the services offered by the Corporation. Further, it was suggested to contact the Business Development Manager of the Technology Development Corporation.

Information received from the Business Development Manager provided an insight into the high technology industry as a whole in Adelaide, the goals and workings of Technology Park and Science Park, and a directory of the firms located at each Park. He also supplied materials on the development of Technology Parks

around the world. He was unable to provide any information on high technology firms located outside the two Parks.

The Business Development Manager also suggested that the Australian Bureau of Statistics would have information on the location and numbers of high technology firms in Adelaide. This unfortunately proved not to be the case. The ABS could provide data on the number of firms performing research and development, the amount of money spent on R & D, but they had no information on numbers of high technology firms no matter how defined.

The Economic Development Authority was again approached and fortunately contact was established with the Investment Manager, who was enthusiastic about the proposed study and agreed to look over initial drafts of the literature review as well as the study outline and made several constructive comments on these.

On a further occasion, the Investment Manager also read and commented on the proposed questionnaire. He made various suggestions about issues which the questionnaire could possibly explore, and made arrangements to contact one of the Project Officers at the Economic Development Authority.

The Project Officer had done a considerable amount of work on the high technology industry in Adelaide, and had been instrumental in the compilation of the *South Australian Electronics Industry Directory*. In the absence of any other source of high technology data at the level of the individual firm, it was decided to restrict the study to high technology electronics firms, using this directory as the data base. The directory includes as accurately as possible, all the electronics firms in Adelaide, their location, the number of people they employ and a brief description of the types of products or services which they offer. It also lists telephone numbers

and a contact name within each firm. The Project Officer also mentioned that a similar directory dealing with the software industry in Adelaide, was also in the process of being compiled, although the time limitations would have made it impossible to contact all of the firms listed in that directory as well.

The Project Officer also assessed the questionnaire and made some slight alterations, which he believed would make the questionnaire more 'appealing' to respondents.

The aim of the study therefore was to contact each of the 109 firms listed in the *South Australian Electronics Industry Directory*, although it was discovered that six of them had either gone out of business or moved interstate since the directory had been compiled in early 1994.

Initially only one questionnaire was planned. However after the database was examined more closely, it became apparent that the firms needed to be divided into two distinct groups. The first comprised 95 electronics establishments, which either manufactured a product or provided a service. The second, was a group of eight businesses which supplied components manufactured by other companies, though in some instances, components were customised to suit individual specifications.

Each firm was initially contacted by telephone. If the response was favourable, then an appointment was made and an interview was carried out at the agreed time by the author on a face-to-face basis, usually with the owner/manager or chief engineer in the firm. With the exception of three firms, all of the interviews were recorded on cassette and later transcribed onto a questionnaire form. This allowed the largest amount of information to be collected in the shortest possible

time. On average the questionnaire took approximately 20 to 30 minutes to administer.

The above method of administering the questionnaire was favoured over sending the questionnaires by post to the respective firms with either a covering note, or alternatively a 'follow up' telephone call. From the author's own past experience, such surveys, although easier at the outset, rarely produce satisfactory results. This problem was referred to by Scott (1993) who, in his study of a very large population of electronics firms in Southern California, was dissatisfied with the poor postal response rate (out of a total 2,993 questionnaires, only 110 were returned, that is, some 4 per cent). Scott's database however, was very large, and it would have taken several years to interview all the firms individually, by which time much of the data would be obsolete. Nonetheless, some would argue that to interview a random sample of the large population would have been a better procedure. In the end all Scott got was a small sample, but a very biased one.

Two questionnaires were completed over the telephone, as both interviewees were about to depart on business trips and did not have the time to make an appointment for another day. A further two questionnaires were posted out, following a telephone conversation with the receptionist in the firm, who was uncertain as to who would be the best person to pass the questionnaire on to. Both of these questionnaires were returned, completed, within about two weeks.

The response rate to the questionnaire was very good. Out of a total of 95 high technology establishments, 61 firms took part in the survey, a response rate of 64 per cent. Out of the eight suppliers, five took part in the survey (62.5 per cent). Thus with a total of 66 responses from 103 firms, the overall response rate to the study was 64 per cent. Such a high response rate is very pleasing and since the

form of questionnaire administration eliminated the problem of incomplete questionnaires, it may be assumed that no error from this source is likely.

The two reasons cited by the establishments which refused to partake in the study was that "they did not have enough time", or that they felt that the questionnaire was "far too personal, and would involve revealing too much of the company's affairs". Those who agreed to respond to the questionnaire were very accessible when the firm was contacted initially and with the exception of a couple of firms, an appointment was arranged immediately. On the other hand, the people who eventually turned down the questionnaire were also the ones which were not only difficult to contact (some of these firms were contacted on more than half a dozen occasions), but they were also the ones who could not decide whether they would complete the questionnaire or not. Before a definite *no* was obtained from them, they were contacted by telephone at least twice.

Ideally the study should have included all the electronics firms and should have examined also firms in other high technology sectors, in order to compare the results and establish whether what is applicable to the electronics industry is true for the high technology industry as a whole. Furthermore, it was unfortunate that none of the firms in the database were located at Science Park, in Adelaide's south, as this would have provided an ideal opportunity to examine this second high technology hub and compare it with Technology Park, in terms of its function and the types of firms attracted. Clearly, electronics is only one component of the high technology sector, however, and so far as could be determined, no sampling frame existed which would permit the study to embrace high technology firms in sectors other than electronics. No tenants at Science Park were therefore interviewed.

## 5.3 THE QUESTIONNAIRES

### *5.3.1 The Questionnaire For All High Technology Establishments*

The questionnaire for all high technology establishments (Appendix A) was divided into a number of sections, each one designed to achieve a certain part of the objectives outlined above.

*Origins of the Business.* The section is split into two sub-sections, one directed towards multi-establishment, and the other towards single-establishment firms. For multi-establishment firms, information was sought about the parent company, if applicable, the location of the company headquarters and other Australian branches and the role which the branch in Adelaide plays in the overall corporate structure. For single-establishment firms, the questions focus more on the founder(s) of the firms, their educational qualifications, past business experience, their motivations in establishing a high technology firm and the inputs which have to be assembled.

*The Business in Relation to its Economic Environment.* This section is divided into a number of sub-sections, and the questions are applicable to both single and multi-establishment firms. Part One seeks information on the labour force employed by high technology firms, their skills, qualifications, the work they do, their availability in Adelaide and also the rate of labour turnover. Part Two examines the issue of backward linkages. The questions seek to discover the location of the suppliers, any difficulties experienced in obtaining inputs and the nature of relationships these firms have with their suppliers. Part Three examines other, service-related inputs, purchased by high technology firms. Included here are plant and equipment service, business services, computer programming, keying-in of data, software design, accounting, legal and advertising services. In addition, the

question of links with tertiary institutions in Adelaide is examined, as this kind of relationship is important for the successful development of a high technology industry. Part Four examines forward linkages, in particular the extent to which firms sell to final demand, or provide inputs for other companies. Other issues raised include the location of customers, in order to determine how well linked high technology firms are into the South Australian economy, and whether firms are dependent on any one particular customer. Finally this section examines the relationship between the firm and its customers, for example, to what extent are firms able to customise their products and services and whether firms find that customers' demand are beyond their production capabilities.

*Growth Prospects.* At the present stage in the evolution of the capitalist market economy, the high technology sector is the fastest growing, the most dynamic and the one most likely to be an engine for regional growth and prosperity. This section therefore attempts to discover to what extent this is true for firms in Australia's electronics sector, and explores what directions the firms plan to take in the future, whether there will be an expansion of the current operation or a diversification into other areas of high technology electronics. Furthermore, as has been noted in the literature, there is a number of potential obstacles to the growth of the high technology industry, and hence it is important to identify these. The identification of such obstacles becomes important when examining the attractiveness of Adelaide as a location for high technology firms.

*Location Analysis.* This section examines Adelaide in the Australian context, and attempts to draw a picture of Adelaide's suitability as a location for high technology industry. The consideration of a location at another capital, as well as Adelaide's advantages and disadvantages are examined. Much is also said in the

literature (Malecki, 1989) about the importance of quality of life in the location decisions of high technology firms, hence this issue is also examined. An assessment is also made of how high technology firms perceive the State Government's role in promoting high technology activity.

*Location Factors*. This final section, examining separately firms located at Technology Park and those located off the Park, looks again at the location issue, but at a more micro scale, analysing the locations of the firms within Adelaide and seeking explanations for the locational patterns observed. Firm owners are asked to assess their locational choices and explain how those choices have affected their businesses. This section also seeks evidence on the advantages and disadvantages of a location at Technology Park, and whether the presence of the Park is an advantage for Adelaide's high technology firms, whether they are located there or not.

It needs to be stressed that the conclusions drawn from the result of the questionnaire survey *cannot* be generalised to apply to all high technology firms in Adelaide. What needs to be kept in mind when examining the results of the study is that only *electronics* firms were surveyed and of course only an extension of this study will reveal to what extent the conclusions reached apply to other high technology sectors.

A pilot study was carried out on ten firms, and since no significant problems were found, the questionnaire was left unaltered. Standard quantitative techniques of cross tabulation and regression analysis were used to analyse the questionnaire data, and to produce tables and diagrams.

### *5.3.2The Questionnaire For Suppliers To High Technology Companies*

A second questionnaire (Appendix B), directed towards the suppliers of components to high technology firms in Adelaide, was administered in the same way as the other questionnaire. The aim of the questionnaire was to determine the role of suppliers of electronic components in the functioning of the high technology complex in Adelaide as a whole. The questionnaire sought to discover whether these firms behaved differently from the manufacturers in terms of backward and forward linkages, and whether their location affected the location and functioning of high technology manufacturers.

This second questionnaire is, in essence, a modification of the original questionnaire. The sections titled *Origins of the Business, Growth Prospects, Location Analysis* and *Location Factors* are the same as described above. The only section modified, and which warrants additional discussion is the section labelled *The Business in Relation to its Economic Environment.*

This section is divided into several sub-sections. The first examines the labour force employed by suppliers of components, in terms of the number of people involved in electronics, their skills and qualifications and the type of work which they perform. Additionally, in order to assess if there are differences between the types of people employed by component suppliers and high technology firms, the issue of labour availability is also examined, as is labour turnover frequency.

The next section looks at the import and marketing of components, and attempts to provide an overall picture of the origins of the components which are purchased by Adelaide's high technology firms. Issues examined include the types of components imported, the country or region of origin, whether imported directly into Adelaide from overseas or from interstate, and factors affecting the types of

components purchased. On the marketing side, the relationship between the suppliers and their customers is examined, as well as the issue of developing markets for components.

The same forms of data analysis were used as with the previous questionnaire, although no pilot study was conducted for the second questionnaire because of the very small number of potential respondents.

# 6. STRUCTURAL FEATURES OF SOUTH AUSTRALIA'S ELECTRONICS SECTOR

## 6.1 INTRODUCTION

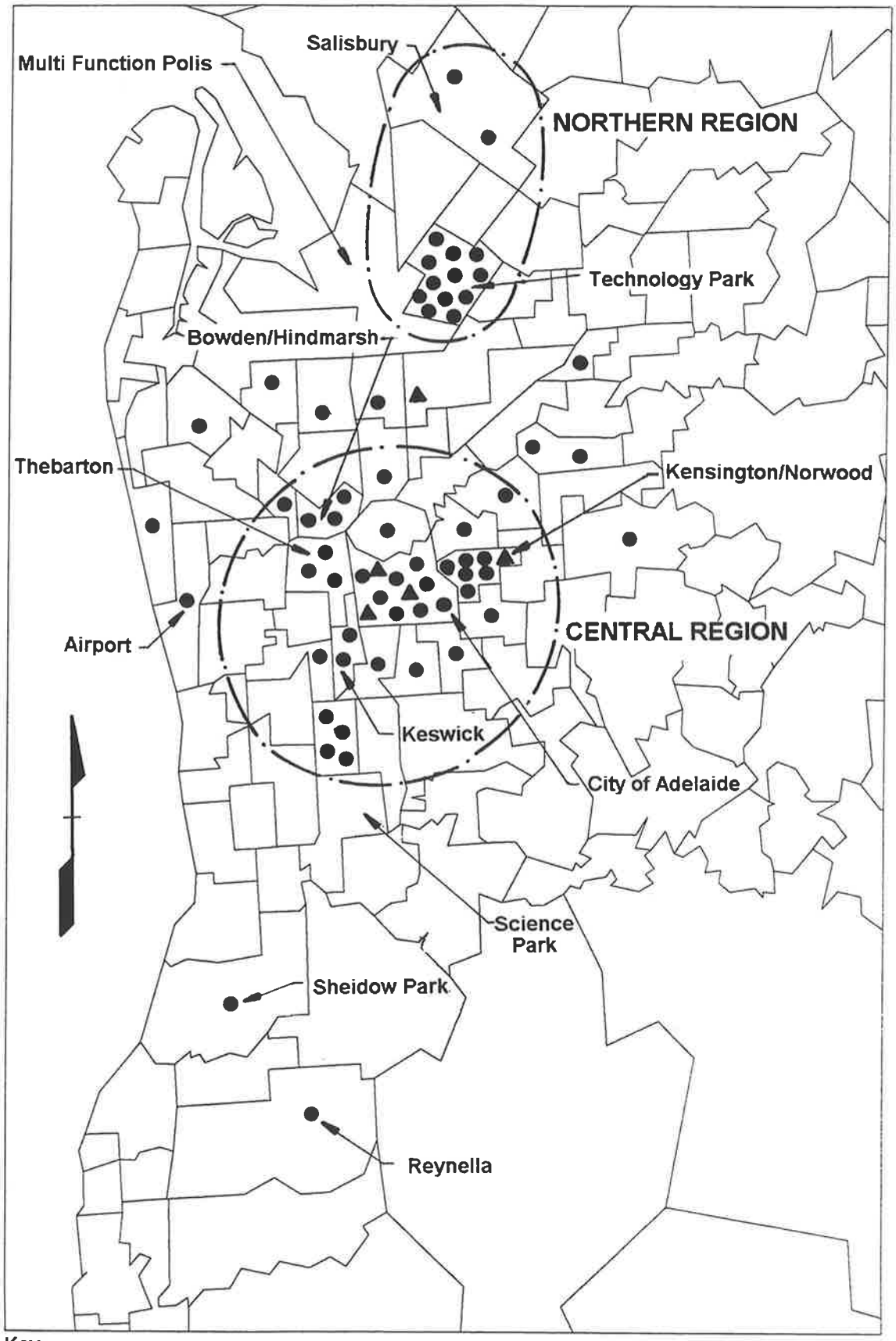
The literature review has revealed that the success of high technology regions is related to a number of structural characteristics of the firms involved. This chapter will therefore, examine the structural characteristics of high technology electronics establishments in Adelaide, beginning with the most fundamental structural characteristic of the electronics sector, namely its location pattern.

Other structural characteristics which will be examined include firm size and ownership. Of particular importance is whether the firm is a branch plant, and if so, the role of the plant in the corporate structure and the location of the headquarters. The chapter will also examine the production and employment profiles of the firms, as the literature suggests that these will affect the environmental requirements of the businesses, in particular their labour and input requirements.

## 6.2 DISTRIBUTION OF HIGH TECHNOLOGY ESTABLISHMENTS IN ADELAIDE

The most obvious locational characteristic is that all high technology electronics firms in South Australia, are located in the Adelaide metropolitan area. Figure 1 reveals that electronics firms tend to agglomerate in two regions of the metropolitan area. The first cluster, which will be referred to as the Central Region,

**Figure 1: Location of High Technology Electronics Firms in Adelaide**



with some 35 establishments, occurs in and around the City of Adelaide, particularly in the city itself and the suburbs of Kensington and Norwood to the east. The second cluster, the Northern Region, occurs in, and adjacent to, Technology Park, with 14 establishments.

The Central Region includes suburbs, such as Bowden/Hindmarsh, Thebarton and Keswick as well as parts of the city square mile, which were traditionally the old industrial core of Adelaide, and would therefore seem to be an unattractive location for sunrise industries (Hall, 1985). However, the function and structure of these areas is undergoing considerable change as larger manufacturers have abandoned them in favour of the outer suburbs, or interstate or off-shore locations. More recently there has begun a process of gentrification, with the renovation of old buildings and the construction of new federation style housing and office facilities (Smith, 1986).

Whilst the concentration of high technology establishments at Technology Park is obviously not unexpected, the majority of establishments outside the city and inner suburbs, tend also to be located to the north of Adelaide. There are in fact only two establishments located south of the city completely remote from any others. One at Reynella, concentrates on the production of electronic equipment for car manufacturers, so that it is in close proximity to Mitsubishi Motors' sites at Lonsdale and Tonsley Park. The other establishment at Sheidow Park is a traditional cottage type establishment, specialising in only one small product (the manufacture of electronic control equipment) and run is from the garage of the owner's home. Two establishments are located at Salisbury, north of, but in close proximity to, Technology Park.

## 6.3 Some Structural Characteristics of High Technology Establishments in Adelaide

The 61 high technology companies surveyed fall into two distinct categories. The first group comprises businesses which are part of multi-establishment enterprises. Some of these are branches of firms with their headquarters located interstate or overseas. The second group consists of single-establishment firms which do not operate any branch plants elsewhere in Australia and which are not owned by any other company. Forty four of the high technology establishments occurring in the study, that is 72 per cent of the total, were found to be single-establishment firms.

### *6.3.1 Multi-establishment Firms*

A total of 17 establishments or 28 per cent of the sample fall into this category. Nine are *Adelaide based* establishments, which operate branches both interstate and overseas. A further seven are branch plants of multinational companies and one is a branch of a Sydney based company.

Out of the seven multinational establishments which have their branches in Adelaide, three have chosen the Adelaide branch to function as the Australian headquarters. Of the remaining four multinationals, one has its headquarters located in Melbourne, two in Sydney and one in Perth. It may be significant that out of a total of 61 establishments surveyed, only eight are branch plants of multi-establishment firms and three of these have chosen Adelaide as a regional headquarters; the remaining 53 establishments are all based in Adelaide. This contradicts a popular perception that Adelaide is 'an overgrown country town, with only a branch plant economy', and indeed (at least as far as this sub-sector is

concerned) suggests that Adelaide's relative peripheral status in Australia by no means removes its ability to develop and attract high technology establishments.

The plants of multi-establishment firms tend to be relatively large, and only three of the 17 employ less than 25 people. However, the largest firm in the survey, employing 350 to 400 staff is in fact a single-establishment firm which has no direct ownership connections with any other firms.

#### 6.3.1.1 The Functional Characteristics of Multi-establishment Firms in Adelaide

Malecki (1989) has discussed at length how high technology establishments tend to separate technical from non-technical workers, and how firms tend to maintain technical activities in core industry centres and disperse production work to satellite centres or branch plants. This is clearly not the case in Adelaide. The eight establishments whose headquarters are outside South Australia all perform research and development activities, either supplementing and complementing the work done elsewhere in the parent company, or alternatively developing products which are unique to this branch and then selling them through other branches of the company.

Also in contrast to Malecki's (1989) findings that high technology establishments tend to disperse production work to branch plants, the nine multi-establishment firms headquartered in Adelaide, as well as being the only research and development centres within the company, are also the sole production facility within the organisation. In other words, unlike the firms described by Malecki, these nine establishments concentrate both their development and production functions on the one site in Adelaide. The other 'branches' are merely sales outlets, although in some instances they may also provide some after-sales support.

The study revealed two exceptions to the above. One establishment based at Technology Park operates a branch in Melbourne, however the two are involved in different activities. The Adelaide headquarters is concerned with the research, development and manufacture of defence related electronics and equipment, while the Melbourne branch is involved in design and manufacture of electronics for industrial purposes. The respondent explained that the reason for the difference in operations between the Adelaide and Melbourne branches related purely to demand. The company directors see Adelaide as being far more involved in defence than any other city in Australia, whilst Melbourne has a relatively small defence manufacturing and design sector, although Victoria as a whole has more industrial activity than Adelaide. This is not to say that the two branches operate in total isolation. There is undoubtedly a certain amount of 'synergy' between them, and research and development conducted in Adelaide, has spin-offs for the industrial sector in Melbourne and *vice versa*.

The other establishment is a branch of a Sydney based multi-establishment firm. Whilst the Sydney headquarters is actively involved in a variety of research and development activities centering upon the building industry, the Adelaide branch is involved in security systems. All of the design and development work relating to new security systems is done locally and, although the final designs are approved by head-office, the Adelaide branch manufactures most of the security equipment, which is then sold throughout Australia. In this respect, the Adelaide branch does not fit the description of a typical branch plant as described by Malecki (1989).

#### 6.3.1.2 Location of other Australian Branches

Out of the 17 multi-establishment high technology firms discussed thus far, 14 operate branches in other Australian capitals. Some firms operate only one branch interstate, whilst others have branches in all major capital cities (Table 1).

Two firms also operate branches overseas, one having a branch in the United States and the other in the United States and Singapore. These overseas branches are no more than sales and distribution offices, which are fully supported by the parent company in Australia. The firm with United States and Singapore outlets has no other Australian locations, all domestic sales being undertaken from Adelaide.

*Table 1: Location of Other Australian Branches of Multi-establishment Firms*

| LOCATION OF OTHER AUSTRALIAN BRANCHES | NUMBER OF FIRMS WITH BRANCHES IN GIVEN CAPITAL |
|---|---|
| Sydney | 13 |
| Melbourne | 12 |
| Brisbane | 10 |
| Perth | 8 |
| Hobart | 6 |
| Canberra | 4 |

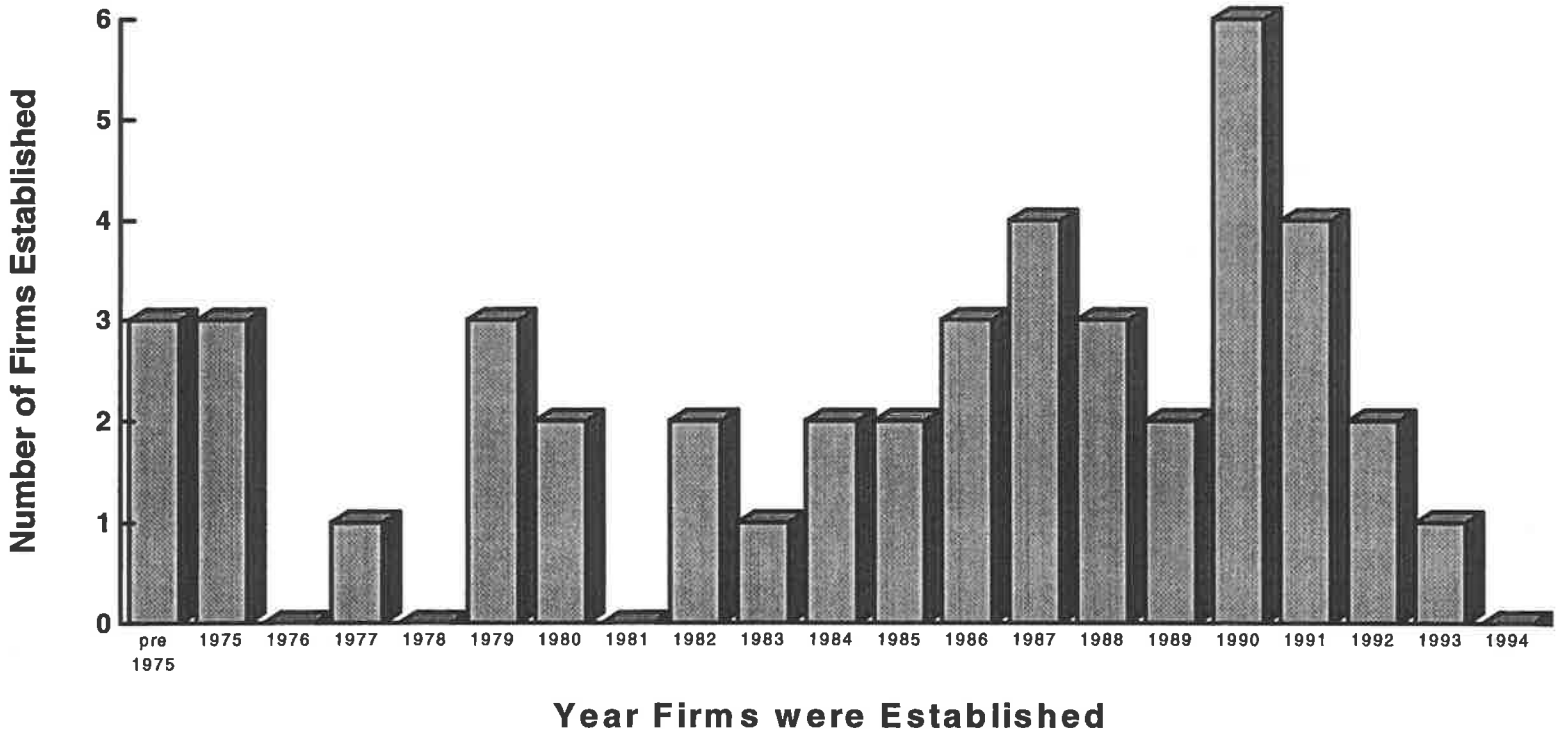
Source: Data from Questionnaire.

### *6.3.2 Single-establishment Firms*

#### 6.3.2.1 Age of Single-establishment Firms

The database for this study relates to firms in existence in March 1994. Of these, three single-establishment firms were founded prior to 1975, whilst the others were founded between 1975 and 1993 (Figure 2). No new establishments were founded in 1976, 1978 and 1981. Between 1982 and 1993, one or more high

***Figure 2***
***Number of Single-establishment Firms Founded per Year***




Source: Data from Questionnaire

technology electronics firms were founded each year, with new firm births reaching a peak of six in 1990 and then tapering off to only one new firm in 1993. There is no information in the database of course relating to firms which had ceased to exist by 1994.

## 6.4 PRODUCTS MADE BY HIGH TECHNOLOGY ESTABLISHMENTS

When one examines the *types* of products made by high technology establishments, whilst all of the products made are, in some way, based on electronics, an extremely diverse production profile emerges (Appendix C). There are, nonetheless, some exceptions. Two of the 17 multi-establishment firms and seven of the 44 single-establishment firms are involved in the manufacture of printed circuit boards. Five single-establishment firms are involved in the manufacture of computer hardware, two in the development of monitoring equipment for rainfall, three in the design of data logging equipment and two in the design and manufacture of process control instrumentation. There is also little variation between the types of products which are made by multi-establishment firms and single-establishment firms, and no products appear to be the exclusive domain of only one type of establishment.

Whilst high technology firms make a wide variety of products, they can be loosely separated into two groups (Table 2. For full details, see Appendix C). The first group includes those firms which make products for final demand. Products referred to in this group are those which are sold to an end user - this can be a household or even another firm - but these products are not sold on to any other customers or incorporated into products which are sold to other customers.

Examples of such products are irrigation equipment controllers, automatic postal sorting machines for Australia Post and time management clocks. This is not to say that these products are not used in the manufacture of other goods. For example, ultrasonic and electrolytic cleaners are sold to firms producing highly sensitive electronic equipment such as printed circuit boards in order to provide the necessary clean environment required for successful production. In this case, it may be considered that the equipment was sold to final demand, as the manufacturer of printed circuit boards is the ultimate end user.

*Table 2: Summary Table of the Types of Products Made by High Technology Firms in Adelaide*

| **MULTI-ESTABLISHMENT FIRMS** | **NUMBER OF ESTABLISHMENTS SELLING THESE PRODUCTS** |
|---|---|
| Products which are sold *only to Final Demand* | 7 |
| Products which are sold *only to Other Manufacturers (Intermediate Products)* | 4 |
| Products which are sold to both Final Demand and Other Manufacturers | 6 |
| **SINGLE-ESTABLISHMENTS FIRMS** | |
| Products which are sold *only to Final Demand* | 18 |
| Products which are sold *only to Other Manufacturers (Intermediate Products)* | 12 |
| Products which are sold to both Final Demand and Other Manufacturers | 14 |

Source: Data from Questionnaire

A product sold to final demand can also be a component, for example, a printed circuit board, but only if that circuit board is used by the customer in the assembly of a piece of equipment which the firm will then use to manufacture its

own products. This is classed as final demand, because the buyer of the circuit board is its ultimate end user.

On the other hand, the second group of firms consists of those which make products for intermediate use. These are usually products which do not have any tangible value on their own and they must be incorporated into other goods, for example, an air conditioning control switch or regulating system is an intermediate product, for on its own it has little value, unless it is incorporated at the manufacturing stage into an air conditioning unit; likewise a remote controller for opening garage doors, needs to be incorprated with an electric garage door motor before it has any real value.

However, and to confuse the issue further, some products can be seen as being either intermediate products or products for final demand, depending on who purchases the products and how they will be used. For example, a printed circuit board can also be an intermediate product - when the manufacturer of the television sets purchases circuit boards from another firm, incorporates them into the television sets and then sells these television sets to the general public, then the circuit board can be regarded as an intermediate product.

What is important to differentiate here though is that some firms surveyed in Adelaide make products for final demand, some make intermediate products for other firms and others still, do a combination of both. As can be seen from Table 2, 25 firms produce exclusively for final demand, 16 firms produce intermediate products exclusively and 20 firms make a combination of both final and intermediate products.

A closer examination of the data failed to find any real correlation between the types of products made, whether for final or intermediate demand, the

organisational structure of the firm, whether single or multi-establishment or the firm's location in the Adelaide Region. What Table 2 does not show is that many of the smaller high technology companies surveyed do not produce anything themselves, apart from prototypes. The mass production of a product is usually done by larger establishments.

## 6.5 THE HIGH TECHNOLOGY LABOUR FORCE

This section examines the labour force employed by the electronics sector, and seeks to establish, in particular, any variation relating to firm structure, establishment size or production profile.

### *6.5.1 Types of Work Performed by Employees*

A problem which arises when discussing the number of people involved in any particular task within high technology firms is that because of the small size of the majority of firms, there is considerable multi-tasking. This means that one person may devote some time towards research and development, some to the building and testing of prototypes and some towards promotion and sales.

In the context of defining "high technology", Hughes (1988) argued for the importance of research and development intensity as a measure of how high tech an industry really is. If this approach is adopted, then the establishments surveyed in Adelaide are very high tech indeed. Whilst the proportion of people involved in research and development varies considerably from one company to another, an average of 74 per cent of employees is involved in R & D. This is not surprising though, as Oakey *et al* (1988) have also noted that small single-establishment high technology firms develop innovative and custom-built devices, which come

about as a result of intensive in-house research and development. Although research and development *per se* accounts for a large percentage of the work done by high technology companies, other areas which are closely related to it include software design (which involves 15 per cent of employees), the building and testing of prototypes (11 per cent), and system design and integration (seven per cent).

A frequently overlooked aspect of high technology industries is employment in the manufacture of products, that is, the low-tech jobs. This study has found that, on average, some 23 per cent of all high technology employees fall into this category. This finding is in contrast to those made by Glasmeier (1985) and Malecki (1989), who both noted larger proportions of people involved in the routine manufacturing and assembly of high technology products.

Another area of employment often neglected is that of product sales and service. These two areas account for some 21 per cent of high technology employment in Adelaide. Companies which manufacture products need to provide an after-sales service during the warranty period and beyond, if customers are to have any faith in the particular brand. In smaller establishments the research and development staff often wear many hats, being involved also in sales and service, however larger companies have their own sales and service divisions.

### *6.5.2 Employees' Skills and Qualifications*

By far the most widely employed people in the high technology establishments surveyed are electronic engineers, who are found in 80 per cent of establishments, and electronic technicians, who are found in 46 per cent. While this study is concerned with only one high technology sector, namely electronics, these figures nonetheless confirm Weiss' (1983) findings that a characteristic of

high technology sectors is the substantial proportion of the labour force in the scientific, professional and technical categories. These jobs generally require at least an undergraduate university degree and very often advanced graduate training. Table 3 shows the types of qualifications which are found among employees in Adelaide's high technology electronics sector. What these findings reveal is that highly skilled personnel are absolutely crucial to the very existence of the high technology industry as a whole.

*Table 3: Percentage of Establishments Employing People with Specific Skills/Qualifications*

| EMPLOYEES' SKILLS AND QUALIFICATIONS | PERCENTAGE OF ESTABLISHMENTS EMPLOYING THESE PEOPLE |
|---|---|
| Electronic engineers | 80% |
| Electronic technicians | 46% |
| Software engineers | 18% |
| Electrical engineers | 13% |
| Mechanical engineers & Computer programmers | 8% each |
| Electricians | 7% |
| Graduates with Science Degrees | 5% |
| Physicists | 3% |
| Geologists, Chemists, Industrial engineers & Accountants | 2% each |

Source: Data from Questionnaire

### *6.5.3 The Distribution of Employees between Small and Large Establishments*

In a study of high technology environments in the United Kingdom, Keeble (1988) found that while many of the high technology industries such as aerospace and telecommunications are dominated by large, frequently multinational, multi-

establishment firms, there has been over the past decade a substantial growth in the numbers and importance of small single-establishment high technology firms.

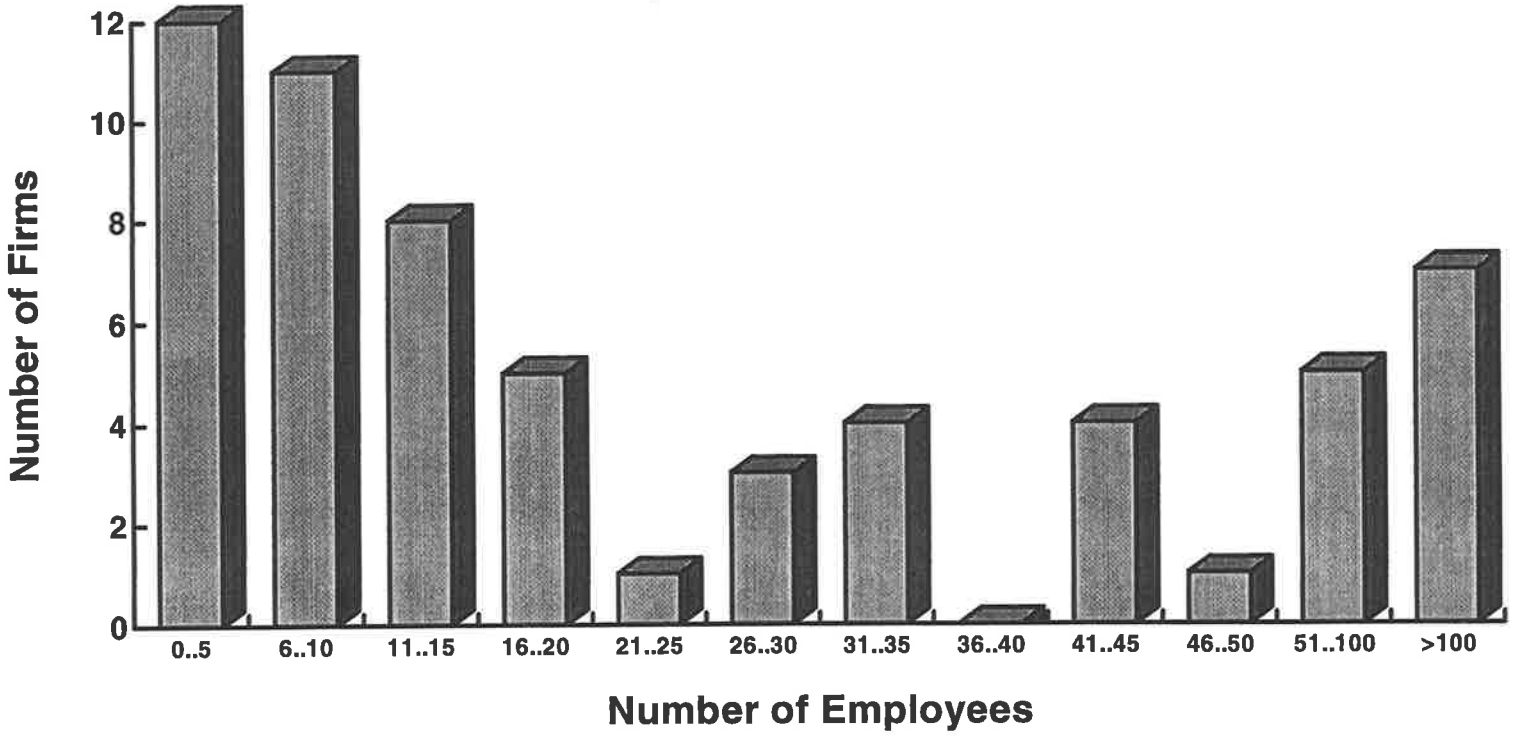
The present study has revealed that some 5,200 people are employed in the high technology electronics sector in Adelaide. Small and medium sized establishments, employing less than 25 people, account for 61 per cent of the total high technology electronics employment. Small establishments, with less than five people, employ 20 per cent of all employees, followed closely by establishments employing five to ten people with 18 per cent of total employment.

On the other hand, larger establishments employing more than 25 people, account for only 39 per cent of total employment in the high technology electronics sector in Adelaide. Establishments employing between 25 and 100 people account for 28 per cent of total employment, whilst those employing more than 100 people account for only a mere seven per cent (Figure 3).

For the purpose of this study, all jobs in the electronics sector were classified into two groups. The first group consists of high-tech jobs. Included in this group are the people who are directly involved in the design of electronics products or processes and the associated software and the testing of such products, namely the electronics, electrical, software, mechanical engineers and so on. The second group consists of the more routine, low-tech jobs. Included in this group are the people involved in the routine manufacture and assembly of products, the sales staff and administration support staff - that is, all those not involved directly in the electronics side of the business.

There is no clear relationship between the size of the establishment and the number of people employed in the high-tech jobs as against the number employed

***Figure 3***
***Size of High Technology Firms by Number of Employees***



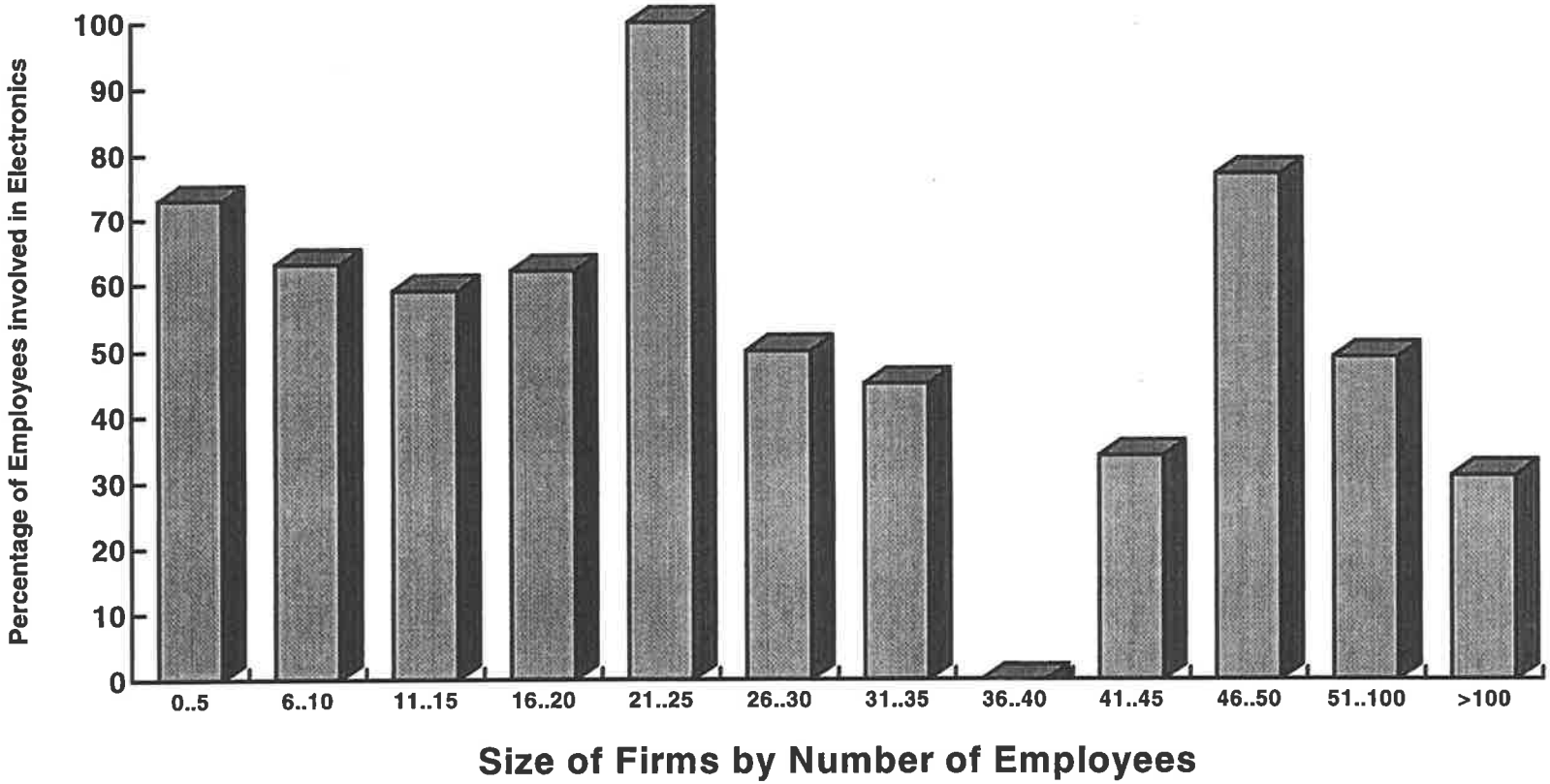

Source: Data from Questionnaire

in the low-tech jobs, although Figure 4 seems to indicate that as firms get bigger there is a slight decline in the proportion of high-tech jobs.

In small and medium establishments employing under 25 people, 64 per cent of employees are employed in high-tech jobs. This drops to 59 per cent in establishments employing between 25 and 100 people, and even further to 31 per cent for establishments employing more than 100 people. The problem of multi-tasking needs again to be stressed for in small and medium establishments, the people who are involved in the design and development of products are usually also involved in the manufacturing process. This means that in these smaller establishments it is much more difficult to separate employees involved only in high-tech jobs from those involved only in low-tech jobs. However, what these findings demonstrate is that 51.3 per cent of the high technology labour force in Adelaide is involved in high-tech jobs. This contrasts sharply with Scott's (1993) findings that only 24.7 per cent of the workers in the electronics industry in Southern California are engaged in managerial and research and development occupations (Figure 5).

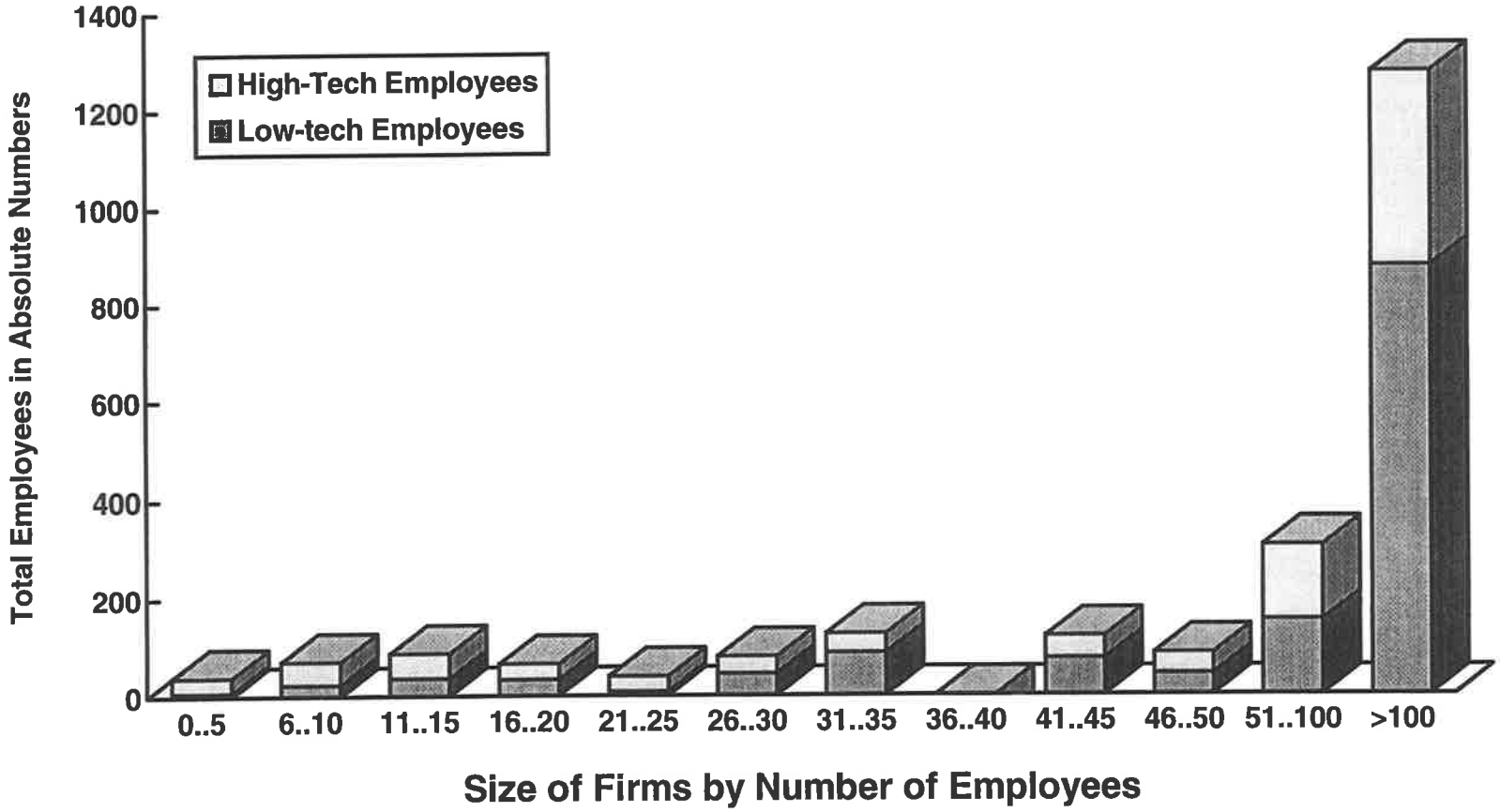
Keeble (1988) found that small high technology establishments are frequently engaged in research and development and in specialised manufacturing, whilst mass production of high technology products is generally the province of large establishments. This certainly seems to be a plausible explanation for the distribution of employees between high and low-tech jobs in the electronics industry in Adelaide, as many of the smaller high technology companies surveyed do not produce anything themselves, apart from prototypes. The mass production of a product is usually done by larger establishments. Larger establishments on the other hand, may have a research and development team to develop products

***Figure 4***
***Influence of Firm Size on Percentage of Employees Involved in High-Tech Jobs***




Source: Data from Questionnaire

***Figure 5***
***Distribution of Low and High-Tech Employees***




Source: Data from Questionnaire

and processes in-house, but a large proportion of their work is to produce components and/or whole products for other, and frequently smaller, customers. These establishments also employ marketing and sales staff, as well as secretaries, receptionists, accountants and the like. Thus while these establishments may do substantial amounts of research and development, the overall numbers involved in electronics as a percentage of total employment is reduced. In other words, in larger firms, there tends to be a greater technical division of labour. Some large high technology companies do not do any in-house research and simply produce, for example, printed circuit boards according to their clients' specifications.

### *6.5.4 Availability of Employees in Adelaide*

Given the crucial importance of the labour force to the viability of the high technology electronics sector as has been revealed in the previous section, the availability of such labour is an important factor for the survival and growth of a high technology region.

When examining a potential location for a high technology establishment, Rees & Stafford (1986), found that one of the criteria which are considered to be of significance is the availability of an appropriately skilled labour force. Adelaide performs favourably in this respect, with 78 per cent of all high technology staff being employed from Adelaide. Only 14 per cent were recruited from interstate and eight per cent from overseas. The main reason given for staff having to be recruited from outside Adelaide was that they could not be found locally, and that the appropriately skilled staff cannot be found in Australia.

The degree of difficulty in recruiting appropriate staff seems to be related to the *type* of work performed and hence to the specialist nature of the staff required to perform that work. What becomes evident when looking at the problem of staff recruitment as a whole, is that on a more micro level, Adelaide seems to lack the very highly specialised and skilled people (that is the 14 per cent who had to be recruited from interstate), who tend to favour the eastern seaboard, especially Melbourne and Sydney, with their more specialised research and development work and greater work opportunities. On the macro scale however, it is clear that Australia as a whole lacks some very specialised expertise, especially in the field of defence engineering. This is underscored by the fact that eight per cent of employees had to be recurited from overseas, as no individuals with the skills required by their employees, could be found within Australia.

### *6.5.5 Labour Turnover*

Whilst Scott (1988), on the basis of mainly American research, concluded that high technology industries are characterised by elevated rates of labour turnover, quite the opposite is found in Adelaide. The respondents were asked to rate the frequency of labour turnover; it needs to be remembered that the answer to such a question, without exact figures of how many people gained and lost employment with a particular establishment, is somewhat subjective. Nonetheless, 12 per cent of respondents said that from the time the establishment was founded there had been no labour turnover at all, 40 per cent said that their labour turnover was *very low*, 44 per cent rated their labour turnover as *low* and three per cent said that they had a *medium* rate of labour turnover. Further, three per cent of the respondents stated that although they had *low* rates of turnover of

skilled research and development staff, they had a *high* rate of turnover among the routine assembly workers.

This last finding agrees with the results of Scott's (1993) survey of high technology electronics firms in Southern California. Scott notes that labour turnover among production workers is, on the whole, extremely high. He found layoff and recall rates of between 25 and 50 per cent. The findings of Scott's work cannot however, be compared directly with the findings of this study, as Scott focused on *production workers only*, and did not examine the rates of turnover among workers in the managerial and research and development occupations. While this study did not attempt to determine the separate rates of turnover for research and development and production workers, it did nonetheless, focus on all employees of high technology electronics establishments.

The above findings suggest that employees working in high technology establishments in Adelaide have more job satisfaction than their overseas counterparts and hence are less likely to want to change employment. Perhaps because of the fairly unstable job climate over the past few years, employees have been reluctant to change jobs, even though they may not be fully content with their current positions. But perhaps most important is the relatively small size of the South Australian high technology sector compared to, for example the United States, so that it may be difficult for a person to find another position within the industry, without having to migrate to another capital. In other words, occupational mobility is constrained by the need for geographical mobility.

## 6.6 CONCLUSION

This chapter has attempted to examine the structural characteristics of high technology establishments in Adelaide. Before a structural analysis could be

made, it was necessary to examine the location of Adelaide's high technology electronics establishments, which occur in two main clusters - the Central and Northern Regions.

The study has also revealed that, contrary to popular perception, Adelaide does not have a branch plant economy, and that indeed, almost half of the multi-establishment firms are headquartered in Adelaide. This has significant implications for the South Australian economy, as the presence of company headquarters is almost always associated with the main research and development facility of the firm. Furthermore, the study has shown that the company headquarters are usually the only production facility within the firm. The study also revealed that the majority of firms are in fact single-establishment firms which do not have any ownership links with other organisations. These varied enormously in both size and age.

High technology establishments make a variety of electronics products ranging from those which are sold directly to final demand to intermediate components which are sold on to other electronics firms both in Adelaide and further afield. Many companies do both. The study also showed that there is very little product duplication and indeed, many firms are unique in what they do.

The chapter also focused on the high technology labour force, examining the types of people employed and their job description. Adelaide's high technology firms employ a diverse labour force, ranging from specialised engineers and technicians to routine assembly workers, as well as general office administrators. The study revealed that the Adelaide region is capable of supplying nearly all of the employees which are sought by high technology firms and that there are only a few cases, where very highly specialised skills are required and these people need to

be 'imported' from other regions. It was revealed that there is a technical division of labour within Adelaide's high technology sector, and this becomes more prominent in the larger organisations. Contrary however to evidence from the overseas literature, Adelaide's high technology firms overall experience a very low labour turnover, with only a small percentage of firms noting high turnover amongst the low-tech employees.

# 7. The Founders of High Technology Firms and their Motivations for Establishing the Business

## 7.1 Introduction

Much has been said in the literature (Glasmeier, 1985; Malecki, 1989; Oakey *et al,* 1988; Saxenian, 1994; Weiss, 1983) about the high technology labour force. The founders of high technology establishments however, are rarely discussed beyond a passing mention. Yet without these people, their ideas and motivations, most of the high technology firms would not have been established.

This chapter therefore, has three principal aims. The first is to identify the founders of single-establishment electronics firms, in order to see what *types* of people (in terms of educational background and professional status) establish high technology firms. The second is to explore the factors which motivated these people to establish a high technology business. Finally, the chapter seeks to discover what resources were perceived by these founders to be necessary for the establishment of their firm. Due to the difficulty of talking to the owners/founders of multi-establishment firms located interstate or overseas, this subgroup has been omitted.

## 7.2 Educational Background of the Founders of Single-Establishment Firms in Adelaide

When attempting to construct a profile of the founders of single-establishment high technology firms in Adelaide, it becomes apparent that whilst the majority have some type of engineering degree, 26 per cent have formal

training in quite unrelated fields. Table 4 summarises the formal qualifications of the founders of single-establishment high technology firms.

*Table 4: Types of Qualifications Held by Founders of Single-establishment Firms*

| QUALIFICATIONS HELD BY FOUNDERS | PERCENTAGE OF FOUNDERS HOLDING QUALIFICATIONS |
|---|---|
| Electronic engineering | 52% |
| Electrical engineering | 11% |
| Mechanical engineering | 7% |
| Business & Accounting Degrees | 7% |
| Bachelor of Arts Degree | 2% |
| Agronomy Degree | 2% |
| Various other Degrees | 18% |

Source: Data from Questionnaire

It was unfortunate that when the company founders were asked where they had worked previously, many declined to answer the question and hence only 19 responses have been obtained. Seven people stated that they had worked in defence related areas before establishing their own company, while four had worked previously in telecommunications. Other individuals have been employed in the following areas: Department of Mines and Energy, Medical Research, Company Management, CSIRO, Applied Chemistry, Computer Programming, Academia and working for a crane company.

Felsenstein & Shachar (1988) have noted how the defence industry has influenced the growth of high technology industries in Israel, where only 19 per cent of high technology firms are outside the electronics/communications equipment/aeronautics nexus that has formed the mainstay of advanced military

production. Whilst the same degree of specialisation in not apparent in Adelaide, the defence and telecommunication sectors have nonetheless had (in the form of spin-offs) a significant influence on the formation of new high technology firms.

## 7.3 Circumstances Surrounding the Births of Single-Establishment Firms and the Motivation of their Founders

The survey has revealed five ways in which the high technology electronics establishments in Adelaide have come into existence. In addition there is an underlying motivation which seems to be rarely referred to in the literature, namely, a desire to improve one's economic circumstances. Put bluntly, there is a desire to "make money". Starting a small business provides not only "independence", but also opportunities for accumulating wealth. Of course, it is possible that neither of these motivations will be fulfilled. "Independence" may be a mirage and the failure rate of small businesses is well known.

Obviously, in most cases, there was more than one motivating reason for establishing a high technology firm. Often these reasons and how they are related are unclear to the founder of the firm and they become even more blurred over time.

The reasons or motivations for establishing a high technology business can however, be divided into two rather loose groups, namely those which are demand driven and those which are supply driven. Table 5, summarises the motivations behind the birth of single-establishment firms in Adelaide (For full details, see Appendix D). Upon examining Appendix D, it immediately becomes clear that in nearly all of the cases, there was more than one reason for establishing the firm, and that for most firms, both supply and demand driven factors played a significant role.

Oakey (1985) has found that the dynamic nature of the high technology sector facilitates the continuing entry of many small firms to fill emerging new production and market niches. The study showed this to be one of the most significant factors which motivated founders to establish high technology electronics firms. While 45 per cent of respondents stated that this was a significant motivating force in establishing their businesses, it is obvious from Appendix D, that many of these respondents also stated that they had a desire to be the "boss". Another motivating factor, linked closely with the desire to fill a market niche, is the desire to serve a particular industry. Eighteen per cent of respondents noted this factor, although again, a number of respondents also referred to their desire to fill a market niche.

*Table 5: Summary Table of the Motivations of Founders of Single-Establishment firms*

| DEMAND FACTORS | NUMBER OF RESPONDENTS CLAIMING THIS MOTIVATION |
|---|---|
| To serve a particular industry | 8 |
| To fill a particular market niche | 20 |
| **SUPPLY FACTORS** | |
| The desire to be "one's own boss" | 17 |
| Friends formed a partnership - wanted to run their own firm | 5 |
| Established by the South Australian Government to commercialise a product | 2 |
| To develop an idea which was formed during previous employment | 10 |
| Business developed from a hobby | 6 |

Source: Data from Questionnaire

Malecki (1985), in a study of high technology industries in the United States found that the most common way in which new establishments came into existence was by spinning-off from existing companies. In Adelaide, 23 per cent of the establishments surveyed came into existence in this way. Their founders decided to

leave the company which was employing them to establish their own businesses, either to continue working in a similar field, or to develop an idea which they formulated while working for their previous employer.

The personal desire to establish an electronics business was another motivating reason (39 per cent of all firms surveyed). The founders of such businesses had previously worked for large organisations predominantly within the electronics and telecommunications industries, but became discontented with their work, or with working for someone else and hence decided to establish a business where they could 'be the boss' and pursue a line of work which interested them. This group of founders differs from the previous group in that they did not 'spin-off' to pursue an idea developed at work. This is not to say however, that none of these businesses were created as a result of a spin-off, but rather that the desire to 'be the boss' became the motivating force behind the establishment of the business. Without this desire, it is quite possible that the founders would not have established the firm in the first place. "Spinning-off" therefore, became the *way* to establish the firm, but not the motivation behind it.

A further group of businesses (14 per cent) grew out of small operations in the founders' back sheds. These activities were frequently nothing more than a hobby initially, but over time the commercial potential of the particular products/inventions was realised and the founders eventually abandoned their paid employment and started their own businesses.

Similar circumstances have been documented by Amin (1989) in her study of small high technology firms in the 'Third Italy'. Amin found that the growth of small high technology firms had occurred because of an increase in the spirit of entrepreneurship and a desire for self-employment. Furthermore she found a

growth of craft industries, specialising in the manufacture of a limited number of specialised products, usually in a shed or small building attached to the founder's residence.

Five establishments were founded by a group of friends who decided to form a partnership and start their own business. In one instance, the new partners simply wished to run their own business, without having to work for anyone else, in another, the formation of the partnership allowed the founders to spin-off from their previous employment and pursue their own line of work, while in yet another case, the partnership allowed a business to develop out of a hobby. The remaining two respondents gave no reasons for their decision to form a partnership.

Two businesses were established by the government to fulfil a specific purpose, in particular to commercialise products which were originally developed for government purposes, but which attracted interest from the private sector. These establishments have then gone on to design and develop new products and effectively become completely autonomous enterprises. In both instances, the government has relinquished all control over the establishments and they now function as wholly private companies.

### *7.3.1 Resources Needed to Establish a High Technology Firm*

A very important factor in the successful establishment of the business which was emphasised by 61 per cent of founders is knowledge of the industry, and the contacts which had been established in their previous place of employment. Without these, they would have found it almost impossible to discover and make contact with potential clients. The respondents also stressed that without such contacts, it would be very difficult to locate the suppliers of particular components,

especially as large organisations and database suppliers overseas are often reluctant to deal with small establishments.

Another important input at the founding stage is, inevitably, finance. Forty three per cent of all individual companies surveyed said that they needed to get access to start-up capital. There was also a number of problems associated with getting this support, with the reluctance of banks and financial institutions to lend money to a small business being the major one. In other cases, founders had access to significant capital to establish the business, but needed financial support within a few months when, for example, they were ready to start production. And once again they faced a similar reluctance by financial institutions and needed to 'shop around' before they could obtain the necessary finances.

This lack of venture capital for high technology companies is not however, specific to Adelaide. Indeed Philipson (1996) notes that in Australia as a whole, bankers are very reluctant to lend money if they cannot see "bricks and mortar, or a warehouse full of stock" (p. 42). It would seem that bankers here have not taken into account that assets in the high technology/information age, are different from those of a previous era. Philipson compares this to the American situation, especially Silicon Valley, where there has been a general willingness to fund new (and potentially risky) ventures, which is so lacking in Australia. In contrast to Australia, venture capitalists in the United states lend money on the basis of a good idea.

Almost one-third of all single-establishment firms saw the availability of a suitably skilled labour force as being a necessary condition for the establishment of a high technology business. Most small establishments do not have the time and the resources for 'on the job' training, and hence have to find people who already possess the necessary skills. This is made all the more difficult by the fact that high

technology establishments frequently work as consultancy firms and hence they may design and manufacture many diverse products. This requires employees to be very flexible and be able to adapt to various projects. Furthermore, it may be necessary for employees to undertake different tasks within the organisation, such as administrative and marketing work, when there is less design or manufacturing work to be done. Once again this calls for employees who are capable of, and willing to, do these various tasks.

Like other small and medium sized businesses, small high technology establishments do not always have the resources to employ business managers and secretaries to do the administrative work. Thus the knowledge of business skills was deemed to be an essential element in running a high technology business by 23 per cent of all respondents. Apart from doing the major design and/or manufacturing work in the company, firms owners/mamagers also had to deal with all the standard office duties which accompany the running of any business.

Finally two minor inputs were also mentioned. The availability of adequate premises (three respondents) and the availability of necessary equipment (two respondents). Whilst these two were seen by some respondents as being important to the successful establishment of a high technology business, there were no difficulties associated with either of them.

## 7.4 CONCLUSION

This chapter has attempted to analyse the educational background of people who establish high technology firms, to categorise the main factors which motivated the founders of high technology firms, and also to examine some of main

inputs which were noted as being necessary for the successful birth and development of high technology firms in Adelaide.

When discussing the motivating forces behind the establishment of a high technology firm, it is important to remember that there is frequently more than one reason for the establishment of the firm and that it is often difficult, if not impossible, to determine which had the greater influence. Likewise it is difficult to categorise firms in relation to whether they were established as a result of demand or supply driven factors. It would seem that for many businesses, there was indeed a combination of both.

Similarly, a number of resources was identified, which had an impact on the establishment of high technology firms. As with motivations, however, it is difficult to ascertain which resources were the most important, and in reality there was again probably a need for a number of inputs.

# 8 . *BACKWARD* LINKAGES AND HIGH TECHNOLOGY ESTABLISHMENTS

## 8.1 INTRODUCTION

The importance of linkages to high technology establishments requires close examination. Linkages are important for two main reasons: first, the availability of necessary inputs and services in a region, that is *backward linkages*, will make that region more or less attractive for high technology establishments and second, linkages are the means by which a high technology establishment impacts upon the local economy through the marketing of its particular products, that is, through *forward linkages* (Scott, 1993; Fingleton, 1992).

This chapter, focusing on the former, will attempt to determine what types of goods and/or services are required by high technology establishments in Adelaide and how readily they can gain access to these inputs. It will also examine another kind of backward linkage that is often claimed to be important in high technology regions, namely the contacts which high technology establishments have with universities and other tertiary institutions, and the role these contacts play in the success of a high technology establishment.

## 8.2 MATERIALS AND COMPONENTS PURCHASED BY HIGH TECHNOLOGY ESTABLISHMENTS

Table 6 outlines the types of inputs purchased by high technology establishments, and the percentage of establishments which purchase these particular inputs. This being a study of high technology *electronics* establishments, it is not surprising that electronic componentry is undoubtedly the most widely required input. Indeed 80 per cent of all the surveyed establishments purchased such inputs, including capacitors, resistors, semi-conductors and the like. Metal housing products, into which the various components are installed, is the second most highly required input.

*Table 6: Types of Inputs Purchased by High Technology Establishments*

| INPUTS PURCHASED BY HIGH TECHNOLOGY ESTABLISHMENTS | PERCENTAGE OF ESTABLISHMENTS PURCHASING INPUTS |
|---|---|
| Electronic components | 80% |
| Metal housing products (casings) | 46% |
| Printed circuit boards | 41% |
| Moulded plastic products (casings) | 20% |
| Silicon chips & electrical components | 10% each |
| Commercial software | 5% |
| Chemicals, microwave components & mechanical equipment | 3% each |
| Laser technology & ceramic discs | 2% each |

Source: Data from Questionnaire

Although nearly one-half of all establishments list printed circuit boards as one of their main inputs, only a handful of high technology establishments actually produce them for themselves (Table 2). Printed circuit boards tend therefore to be

the product of specialist firms. Businesses incorporating printed circuit boards into their products, purchase them custom made to the establishment's specifications.

### 8.2.1 Location of Component Suppliers

Oakey *et al* (1988) have found that backward linkages tend to have an impact on the management of innovation in high technology establishments. Whilst the managements of these establishments cannot influence directly the quality and choice of local input suppliers, they may nonetheless find it beneficial if such inputs are available locally. Furthermore, the presence of a wide range of local input materials may be critical for only a few establishments, important for most establishments and totally insignificant to a further minority of establishments. This is dependent on the type of work the establishments do and the types of products which they produce, if indeed they manufacture anything at all.

It is clear that in South Australia the availability of locally supplied inputs is important to high technology establishments and that they do prefer to purchase their inputs from local sources. In fact, 74 per cent of all establishments surveyed sourced at least some of their inputs locally. Whilst on the surface this figure suggests a very large local input, it needs some qualification. First, the majority of inputs which are sourced from local suppliers are actually manufactured overseas and the suppliers act merely as distributors for overseas manufacturers. The reality is that inputs manufactured in Adelaide, or indeed in Australia, constitute a very small proportion of all the inputs purchased by high technology establishments. Second, although a high technology establishment may purchase *some* inputs locally, the fact is that this is usually a very small percentage of total input purchase, and most inputs would be purchased either from distributors interstate (39 per cent

of all establishments) or directly from overseas manufacturers (59 per cent of all establishments). The main countries noted as being suppliers include Thailand, Korea, Taiwan, Germany, Switzerland, Denmark, Italy, United Kingdom, United States and Japan.

The above circumstance however, does not seem to be specific to Adelaide, although it may be exaggerated to a certain degree by Adelaide's relatively peripheral status in Australia. Hagey and Malecki (1986) have discussed a similar situation in the United States and have concluded that such diverse linkages may be related to the fact that high technology industries require more specialised inputs than are utilised by other manufacturers, hence high-tech establishments are most likely to have widespread, rather than local linkages because no single region can provide all the necessary, and frequently unique, inputs.

However, as mentioned earlier, an input often required by high technology electronics manufacturers is printed circuit boards, and indeed the study has found that nine firms actually make them themselves. Since the vast majority of circuit boards need to be made to a customer's specific requirements, circuit board manufacture therefore involves significant levels of transactions-intensive interactions between the manufacturer of the circuit board and the customer (*cf.* Scott, 1993). This need for frequent contacts between customer and supplier means that the suppliers of the inputs tend to locate close to their potential customers. Thus, whilst high technology firms may indeed have widespread linkages, it would seem that the nature of the products required by a high technology firm influences the diversity and scope of a firm's linkages.

## 8.3 SERVICES PURCHASED BY HIGH TECHNOLOGY ESTABLISHMENTS

Markusen *et al* (1986) found that many emerging high technology establishments will locate near other, already established, high technology enterprises in order to take advantage of agglomeration economies, which are important for high technology firms; such economies include the exchange of information and ideas, which is fundamental to the success of a high technology industry. Markusen *et al* conclude, that the availability of such services is important to the success of an area as a high technology location.

The situation described by Markusen *et al* (1986) above, holds true for Adelaide. All of the establishments surveyed are highly dependent on the support services which are offered by other establishments located in Adelaide, as many of them simply do not have the financial means to be able to provide all of the services in-house, and as previously described, only seven percent of the founders actually possess business or accounting degrees. The vast majority are engineers, who in most cases, have had very little, if any, experience or training in running a business. Table 7 shows the types of services which high technology establishments purchase from other companies. When examining the types of services purchased by high technology establishments, several differences become apparent between the types of services purchased by single-establishment firms and those purchased by multi-establishments firms. A significant difference may be noted in relation to the purchase of software design services. Seventy per cent of the multi-establishment firms purchased software design services, compared to only 57 per cent of single-establishment firms. Furthermore, as noted in Table 7, ten establishments (16 per cent) purchased no services from other firms. Of these, nine were single-establishment firms. While

the reasons for these differences are not clear, it may be that small single-establishment firms may not be able to afford to purchase such services, even though their need for them is at least as great as that of the larger businesses.

*Table 7: Services Purchased by High Technology Establishments*

| SERVICES PURCHASED FROM OTHER COMPANIES | PERCENTAGE OF ESTABLISHMENTS PURCHASING SERVICES |
|---|---|
| Software design and/or computer programming | 63% |
| Accounting services | 43% |
| Legal services | 23% |
| Business consultancy services | 15% |
| Contract engineering & electronic design services | 10% each |
| Advertising | 8% |
| Word processing, staff training & transport services | 2% each |
| No services purchased | 16% |

Source: Data from Questionnaire

Whilst the purchase of computer software design services remains the domain of the larger, multi-establishment firms, single-establishment firms mainly purchase the more routine services, which are not specifically linked with high technology industry, such as accounting, legal and business consultancy services. On the other hand, multi-establishment firms purchase far fewer of these services, as they usually employ people to perform such tasks in-house, in spite of recent trends to downsizing and outsourcing.

Advertising and marketing services are purchased in the main by single-establishment firms, varying from the largest firms in the study through to the small firms employing less then five people. By contrast, only one multi-establishment firm purchased advertising services locally. Possible reasons for this include the

fact that the multi-establishment firms which are not headquarted in Adelaide have their advertising done through head office. More significant however, is the fact that the majority of multi-establishment organisations do not do any advertising *per se*. They are usually large well known organisations, and thus most customers approach them, hence they have very little need to advertise their products or services.

### *8.3.1 Location of Service Providers*

In a study of high technology establishments in Florida, Hagey and Malecki (1986) found that such establishments have developed only weak local service linkages. Their study also found that local linkage strength varies greatly according to the type of service. Services of a high-tech nature show a greater tendency to be supplied by non-local sources than do routine services.

The above findings are in direct contrast with the results revealed by this study, for 82 per cent of all establishments interviewed purchase services from other Adelaide-based companies, with only 11 per cent buying services from interstate (Melbourne, Sydney, Tasmania) and a meagre five per cent rely on overseas sources (Germany and United States). And in spite of the frequent findings that non-local firms are more likely to purchase services from non-local sources, (for example Hagey and Malecki, 1986) the companies which source services from either interstate or overseas are not branches of multinationals, but rather locally based establishments. The services which they require to support a specific type of technology are simply not available in Australia. Hence, so far as services are concerned, Adelaide's high technology firms are well linked to the local economy.

## 8.4 Difficulties Experienced in Obtaining Inputs

The previous section has revealed that a large proportion of the components required for Adelaide's high technology electronics sector, must be sourced from interstate or overseas, even if through local agents. The question arises therefore, how great a barrier is this for the development of Adelaide's electronics industry? Answering this question may well suggest ways in which policy makers can alleviate these difficulties.

Two-thirds of all surveyed establishments in Adelaide experienced problems in obtaining some, or all, of their inputs. A major problem faced by 18 per cent of all surveyed establishments was sourcing components. The respondents found it very difficult to find a supplier for particular components which they required and then experienced difficulty having that component delivered. Fifteen per cent of all establishments complained about very long lead times on particular inputs from overseas companies, which means that parts have to be ordered months in advance. Some respondents indicated that this caused a number of problems, as it would not always be possible to anticipate which goods would be needed and in what quantities some months in advance. Ten per cent of the respondents found it difficult to purchase components in small quantities, with most overseas companies wanting to sell items in bulk.

Other problems faced by high technology establishments included the inability to purchase many components in Adelaide, and the need to order almost everything from interstate (five per cent), incorrect products being sent from overseas, the difficulty of contacting the overseas company to have the goods returned and the correct ones sent out (five per cent) and the expense of having

themselves to import components, because no distributors stock those particular components in Australia (three per cent).

The single biggest problem, experienced by 23 per cent of all establishments was caused by shipping delays. The respondents noted that goods took an extraordinarily long time to be delivered over relatively short distances and that frequently goods would not arrive on the specified day. This caused problems such as stalling production and/or resulting in excessive down-time in manufacturing as a project would be unable to proceed until the required part arrived.

The problem of shipping delays is more serious in high technology establishments than it is in other manufacturing establishments, since, as Schoenberger (1988) has discussed at length, high technology establishments work to a 'just-in-time' production schedule, where product lines and configurations evolve rather more rapidly than in a standard manufacturing establishment. This means that high technology establishments cannot always plan which components they will need months in advance. Sometimes, to win a tender for example, a high technology establishment must provide a solution to a potential client's problem; time to do this is very limited and the prompt arrival of necessary components has a resounding impact on an establishment's ability to present a successful bid.

## 8.5 Plant and Equipment Service

The servicing of plant and equipment is an area which receives little attention in the literature concerned with the provision of services to the high technology industry. Any equipment which is purchased by high technology

establishments is, in most cases, high tech itself. Thus the question arises, can an establishment readily have such a piece of equipment repaired, or are there difficulties associated with this?

Of all the establishments surveyed, 62 per cent had to train personnel to repair equipment in-house, because finding outside support was almost impossible. This arises mainly because of the fact that most high technology equipment is imported from overseas and there are no companies in Australia which can offer support for the particular product. Some companies (23 per cent) are fortunate enough to use equipment which is sold through a local distribution network and hence access to maintenance and support is only a phone call away. Others (11 per cent) need to return a particular piece of equipment to the manufacturer somewhere in Australia. Although there is a certain amount of inconvenience and cost involved with this, the problems are nowhere near so serious as those faced by those companies (3 per cent) which use, for example, surface mount technology. These establishments cannot repair the equipment themselves and there are no support services available in Australia. In order to have the machines repaired, they must be returned to the manufacturer (either in Germany or Japan). The difficulties, loss of income and so on, this causes for the establishment are obvious, as it is usually some months before the equipment is returned from the overseas manufacturer. Five per cent of the high technology establishments said that it was usually easier, and cheaper in the long term, to replace equipment once it broke down, whilst three per cent had to pay the costs of flying in technicians from overseas to repair particular equipment, as there are no people in Australia who possess the necessary skills to do this.

## 8.6 CONTACTS WITH UNIVERSITIES AND COLLEGES

High technology establishments perform some in-house research and development in order to be innovative in terms of new products and processes so that they may survive in markets where specifications of products are constantly changing. Oakey *et al*, (1988) found however, that they frequently need technical inputs from external resources such as universities and technical colleges. The high technology establishments surveyed in Adelaide are no exception.

In their study, Vaughan & Pollard (1986), found that universities tend to be a prerequisite in sustaining a concentration of high technology establishments. They found that universities provide local establishments with a definite cost advantage in the supply of several critical inputs. Research carried out within the university is a major source of new products and processes and may help solve technical problems for new small establishments that do not as yet have their own research facilities; without such facilities the development of a local high technology industry is difficult, if not impossible. This is certainly true for Adelaide, as 36 per cent of all high technology establishments have some, if not all, of their research and development undertaken at one of Adelaide's three universities, and they also seek advice from universities on particular aspects of design. Five per cent of establishments also run courses at universities and provide guest lecturers as a way of maintaining better working contacts with the universities.

Howells (1986) discovered that the orientation of industrial-academic ties can range from short run development work associated with a specific commercial objective, through to long term basic research which has no immediate commercial application. This has also been found to occur in Adelaide. Eleven per cent of the establishments surveyed said that they work together with a university to

build a particular product which the university has developed, although this product will probably never go into full scale production for commercial sale.

Howells also notes that industrial-academic ties can range from formal ones, as described above, to informal discussions which eventually can lead to the design of a new product with a joint effort from both the establishment and the university. No such informal ties were detected by the study. Furthermore, no establishments were reported to have any informal or social contacts with academia, either through meetings or seminars. Only two establishments were found to have very informal ties with Adelaide's universities, in that they rent building from the universities; the relationship between the universities and these two establishments does not extend beyond that of a tenant and landlord.

Contrary however to the comments of Vaughan & Pollard (1986) above that university-academic ties are essential, 41 per cent of the establishments surveyed in Adelaide do not have any ties whatsoever with any universities or colleges. There is little similarity between these establishments, for they range from very large establishments to those employing only a few people and they are both local establishments and multinational branch plants. It seems that independence from the universities depends on two factors: first, the ability to fund in-house research and development (and for that matter to find the necessary personnel) and second, the type of work being undertaken (clearly the manufacture of printed circuit boards will not require input from a university, although the design of an advanced piece of defence equipment probably will).

## 8.7 Conclusion

This chapter has examined the issues of backward, or input linkages, as well as the links between universities and high technology industry. The majority of

services used by high technology establishments are sourced from other companies in Adelaide, with only a small percentage coming from interstate and overseas. Thus as far as services are concerned, high technology establishments are well linked with the South Australian economy.

Sourcing components though, seems to be one of the major hurdles facing many high tech establishments in Adelaide, with shipping delays causing a variety of problems. This is aggravated by the fact that the vast majority of companies purchase at least some of their components locally, although they may originally be made overseas.

South Australia's electronics sector is very much dependent on material inputs purchased directly from overseas and interstate. Companies also face problems repairing equipment, although a number of establishments have overcome this difficulty by simply doing all the repairs in-house.

As suggested by Vaughan & Pollard (1986), universities play an important role in Adelaide's high technology sector, with nearly half of all the surveyed companies having contacts with one of the three local universities for various design and development work.

The above findings, coupled with the fact that over two thirds of all the establishments surveyed are contemplating expansion in the near future, indicates that, on the surface, Adelaide appears to be a very attractive place for high technology development, although component access is a problem. This chapter, however, has looked at only one of the major 'ingredients' required for high tech development. Another major issue which needs to be addressed is the marketing of products and services, namely *forward* linkages.

# 9. *FORWARD LINKAGES* AND HIGH TECHNOLOGY ESTABLISHMENTS

## 9.1 INTRODUCTION

Unlike input or *backward linkages*, which are concerned with a firm's relationship with its suppliers, sales or *forward linkages* are concerned with the marketing and sales of a firm's products and services. This chapter therefore, will focus on this second aspect of linkages and attempt to determine the ways in which high technology establishments in Adelaide market their products, who are their customers and where they are located. The chapter will examine the ways in which high technology establishments seek out customers and also the barriers which inhibit their access to particular markets.

Initial examination of the data relating to the nature of the products sold and also types of customers which purchase those products has revealed that three distinct types of high technology firms exist in Adelaide - those which sell exclusively to final demand, those who sell intermediate components only to other manufacturers and a third group which do both. Each of the three types will be examined individually. A general discussion will then follow.

## 9.2 FIRMS WHICH SELL ONLY TO FINAL DEMAND

Out of the total database of 61 firms, 25 (or 41 per cent) sell complete products exclusively to final demand. These firms are located mainly in the Central Region, only three being found in the Northern Region within Technology Park.

Seven of the firms are part of multi-establishment organisations, whilst the remainder are single-establishment firms (Table 8).

*Table 8: Firms Which Sell only to Final Demand*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION |
|---|---|---|
| 2. | North Plympton | Design and manufacture of irrigation equipment |
| 5. | Technology Park | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) |
| 6. | Holden Hill | Manufacture of remote control door opening controllers |
| 12. | Forestville | Development of monitoring equipment for the mining industry and software development needed to run the given equipment |
| 13. | Adelaide | Design and manufacture of time management clocks and all associated software |
| 16. | Dulwich | Design and assembly of voice and data communication systems |
| 17. | Parkside | Manufacture and installation of security systems |
| 19. | Eastwood | Design and manufacture of process control instrumentation |
| 21. | Edwardstown | Manufacture of Printed Circuit Boards |
| 26. | Unley | Manufacture of Printed Circuit Boards |
| 28. | Regency Park | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities |
| 29. | Technology Park | Software design; building and testing of various prototypes for the defence industry |
| 31. | Adelaide | Design and manufacture of laser based products |
| 33. | Edwardstown | Manufacture of computer memories, computer hardware and monitors |
| 38. | North Adelaide | Consultancy work for the defence industry |
| 39. | Norwood | Development of communication equipment and the manufacturing of prototypes |
| 45. | Hindmarsh | Production of master compact disks and making of copies |
| 47. | Stepney | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications |
| 48. | Kent Town | Manufacture of portable moisture sensors for the agriculture industry |
| 49. | Norwood | Development of monitoring equipment for rainfall, water quality etc. |
| 50. | Magill | Development of monitoring equipment for rainfall, water quality etc. |
| 51. | Technology Park | Design of silicon chips and integrated circuits |
| 52. | Adelaide | Design of custom electronic systems |
| 55. | Woodville North | Design of data logging equipment, mainly for government utilities |
| 61. | Joslin | Redesign of ageing electronic equipment to reduce costs and increase functions; data communications in a factory environment |

Source: Data from Questionnaire

### 9.2.1 Nature of Products Sold to Customers

When examining the establishments which sell products only to final demand, it becomes clear that two distinct types of products are sold. First are general products which the establishments produce and then sell "as is" without any further modification. For example, Firm No. 2 produces several models of irrigation controllers, but customers cannot have a controller made or even modified for their needs - they simply need to choose the model which best suits their requirements. Second, there are products designed and manufactured to suit customers' specific needs. For example, Firm No. 29 would be approached by some part of the defence forces to design and build equipment for military purposes and all the associated software. Such equipment and software would be designed to suit a particular application and in many cases only one such item would be built.

Ten establishments produce customised products, while 14 establishments produce only general products. Within this group of 25 establishments, only one establishment produces both a general line of products as well as custom made products to suit customer specifications.

### 9.2.2 Location of Markets

In discussing the product cycle hypothesis, Vernon (1979) states that managers of high technology establishments are stimulated by the opportunities of the home market and that the home market is also the preferred location for the actual development of the innovation. Furthermore, Vernon believes that the factor which pushes many innovating firms to do their development work in the home

market is the need to have engineers and scientists with the requisite skills on hand.

The study has found that firms in this group put far less emphasis on the home market than Vernon has suggested. Whilst, all but one of these firms sell at least some of their output within South Australia, all but one of these businesses also sell some of their production to markets in other states, while nine firms (36 per cent) have market links overseas. Thus for this group of firms, exports, either interstate or overseas, are just as important as the local market.

The firms in this group noted that although the local market was responsible for a certain number of sales, the main markets existed interstate, where a far greater demand exists for high technology electronics products. Most respondents in this group claim that they would find it difficult to exist, if they relied solely on the local market.

### *9.2.3 The Marketing of Products*

When examining the ways in which this group of high technology establishments promote themselves and market their products, it becomes clear that they do not have any obvious marketing strategy and that they rely on "word of mouth" as the main means of promoting their products and services. This phenomenon has also been observed by Oakey *et al* (1988), who believe that this less than optimal marketing behaviour is derived from a satisficing approach on the part of the management who are happy to achieve a full order book, and perhaps marginally to expand, but without any great ambition to achieve the maximum amount of sales possible. In examining those firms which sell only to final demand, it is clear that "word of mouth" is the single most important form of

marketing, with 18 firms relying to a greater or lesser degree on this method to gain sales.

However, high technology establishments do use other means of promoting their products to potential customers. Twelve establishments stated that they directly approach potential customers and attempt to sell them the company's products. Customers were usually selected from various electronics and trade magazines, and would be approached if the establishments believed that it could provide the potential customers with some practical solutions, or some products to improve the efficiency and output of the firm. Other ways of seeking out customers included gaining access to various databases which contained lists of electronics firms throughout Australia. Furthermore, and especially applicable to those establishments which were created as a result of a spin-off from another firm, the databases used to find potential customers are usually the same ones which are used by the establishments in which the owner worked originally, and thus spin-off establishments frequently compete with their 'parent' establishments in seeking customers.

Five establishments bid for upcoming tenders and approached various companies with proposals. Their success or failure is reliant upon their ability to present a price-competitive tender and also upon their reputation for producing quality products. Although this form of business may be very lucrative, it is also very 'cut-throat', and frequently the future of such establishments is uncertain, unless new tenders can be won on a consistent basis.

Additionally five other establishments attend various trade shows and conferences and attempt to sell their products through direct contact with potential

customers. Four establishments also advertise their products in various trade and electronics journals, while two establishments use a telemarketing approach.

## 9.3 FIRMS WHICH SELL ONLY TO OTHER MANUFACTURERS

Firms which sell only intermediate products (components) to other manufacturers account for only 26 per cent (16 firms) of the total number of firms surveyed. These firms are again scattered throughout metropolitan Adelaide, with five establishments being located in the Northern Region at Technology Park. Four are multi-establishment firms, and the remaining 12 are single-establishment firms (Table 9).

*Table 9: Firms Which Sell only to Other Manufacturers*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION |
|---|---|---|
| 4. | Hendon | Design and manufacture of electronic components and engine management systems |
| 8. | Unley | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products |
| 9. | Adelaide Airport | Design and manufacture of electronic speed controllers for evaporative air conditioners |
| 14. | Technology Park | Development of radio frequency technology; systems engineering |
| 18. | Thebarton | Design and manufacture of process control instrumentation |
| 20. | Keswick | Manufacture of Printed Circuit Boards |
| 22. | Newton | Manufacture of Printed Circuit Boards |
| 23. | Salisbury South | Manufacture of Printed Circuit Boards |
| 25. | Technology Park | Manufacture of Printed Circuit Boards |
| 36. | Technology Park | Manufacture of computer memories, computer hardware and monitors |
| 40. | Hindmarsh | Design of specialised controllers and all associated software |
| 44. | Kilkenny | Design, development and installation of electronic engine management systems |
| 46. | Prospect | Design and manufacture of microwave communications systems |
| 57. | Technology Park | Design of data logging equipment, mainly for government utilities |
| 59. | Edwardstown | Alterations of security equipment to suit specific applications |
| 60. | Technology Park | Design work for the Department of Defence; in-house development of defence oriented equipment |

Source: Data from Questionnaire

### 9.3.1 Nature of Products Sold to Customers

Ten of the establishments in this group made customised products, while only four firms made general products. Two firms produce general products, but also provide a consultancy service, and make specialised products to order. The types of products made by firms in this group vary quite considerably when compared with those made by firms which sell only to final demand. While more than half of the firms which sell only to final demand, sold general products, firms which sell only intermediate products to other manufacturers are overwhelmingly concerned with the manufacture of products to suit customers' specific needs.

There is no clear reason for this difference, although it may be assumed that the reason lies in the fact that intermediate products are usually components which other manufacturers will incorporate into a product which they are making. This means that such components must perform a specific task, the nature of which is usually determined by the designer and/or manufacturer of the final product. All components purchased externally must therefore perform these specific tasks, and frequently the only way to obtain such components is to have them custom made. On the other hand, firms which sell to final demand do not have to make products for a specific purpose. As long as they can find markets for their products, they have greater flexibility in terms of the types of products which they manufacture.

### 9.3.2 Location of Markets and the Types of Firms Which Purchase Intermediate Products

As with the establishments discussed in the previous section, South Australian, interstate and overseas markets are all important. Fourteen establishments (88 per cent) sell at least some of their products to local (South

Australian) firms, but 14 depend to some extent on interstate and five on overseas markets. However, of those 14 firms which sell both to the local market as well as the interstate markets, all mentioned that the local market was more important than interstate markets. Intermediate inputs (as mentioned earlier, they are predominantly components), must sometimes be purchased "on the spur of the moment". This can occur if, for example, a firm is developing a new product and the engineers realise that a different component might be the solution to a technical problem. In such a situation it is imperative that the components be available locally, or otherwise product development will be stalled. The problems of sourcing components from interstate have been discussed in the previous chapter. For this reason, manufacturers of intermediate inputs focus more on the local market and attempt to satisfy this "on the spur of the moment" demand.

Whilst some establishments were reluctant to discuss who their main customers were, some of the companies which purchase intermediate high technology products include: Email Limited, Toyota, Mitsubishi, General Motors Holden, Ford Australia, Bosch, Arcatel, AWA Defence Industries, Telstra, Defence Science Technology Organisation, Vision Systems, British Aerospace, and various engineering, mining and consulting companies. What is important to note is that many of the firms mentioned above which purchase intermediate components are themselves manufacturers of electronic equipment. This seems to indicate that quite strong linkages exist between electronics manufacturing firms and that they are, at least to some degree, reliant on the local high-tech region to supply them with at least some of the necessary components.

Oakey *et* al (1988) have discussed the importance, especially for small high technology establishments, of maintaining a large number of customers as

well as the dangers faced by those firms which rely on a single customer. The study revealed that in Adelaide, high technology establishments seem to be well insured against such problems, with 12 of the establishments which manufacture intermediate components having a very wide and diverse base of clients. Many establishments commented on the dangers of having a small customer base, as described above, and have noted that while the withdrawal of a customer may have some repercussions on the finances of the establishment (especially in the case of small establishments), nonetheless, it will not result in the closure of the business. However, in a vulnerable position are the four establishments which are reliant on only one main customer. Two of the customers named were Telecom (Telstra) and AWADI. Although the high technology establishments in this group were all very small, generally employing less than five people, they did not seem to be concerned about their reliance on one customer. Interviewees commented that they have had a long standing relationship with their clients and they saw no reason why these clients should choose another establishment to supply them with the necessary componentry.

### *9.3.3 The Marketing of Products*

When examining the marketing strategies of establishments which sell only intermediate products, it is clear that "word of mouth" is once again the predominant form of advertising, with ten firms using this method. The next most commonly used method of marketing the establishment's products (used by six firms) is contacting potential customers directly and attempting to sell the establishment's products and design expertise. Only two establishments market their products in various electronics journals, whilst another two rely on

advertisements in the Yellow Pages nationally. One establishment markets its products through national and international agents.

## 9.4 Firms which Sell to Other Manufacturers and Final Demand

### *9.4.1 Nature of Products Sold*

The remaining 20 establishments surveyed manufacture a variety of products which are sold directly to final demand, and also manufacture intermediate products which are sold to other firms. The respondents would not or could not reveal what percentage of the business concentrates on any one aspect, thus it is impossible to differentiate in this group between those firms which concentrate more on sales to final demand, versus those which concentrate predominantly on the manufacture of intermediate products (Table 10). Out of the 20 firms in this group, eight sell general products to their customers, eight customise their products to suit specific needs and four firms do a combination of both.

### *9.4.2 Location of Markets*

All the firms in this group sell to both the Adelaide market and also to interstate markets. Exactly half of these firms also sell their products overseas, although it is not known what percentage of the goods sold both locally and overseas are intermediate products and what percentage are complete products sold to final demand. Since firms in this group sell both complete products as well as intermediate products, it is not surprising, given the earlier findings, that both local and interstate markets are of relatively equal importance.

*Table 10: Firms Which Sell both Intermediate Products and also to Final Demand*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION |
|---|---|---|
| 1. | Newton | Design and manufacture of communication equipment |
| 3. | Technology Park | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post |
| 7. | Technology Park | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products |
| 10. | Thebarton | Design and manufacture of precision weighing instruments, load cells & digital controllers |
| 11. | Kilburn | Development of load cells, crane weighing systems and their manufacture |
| 15. | Kent Town | Design and development of computer controlled air conditioning systems for hospitals etc. |
| 24. | Adelaide | Manufacture of Printed Circuit Boards |
| 27. | Bowden | Production of safety switches and safety circuits for hospitals |
| 30. | Unley | Design and manufacture of laser based products |
| 32. | Thebarton | Development and manufacture of safety systems for cranes |
| 34. | Edwardstown | Manufacture of computer memories, computer hardware and monitors |
| 35. | Technology Park | Manufacture of computer memories, computer hardware and monitors |
| 37. | Technology Park | Manufacture of computer memories, computer hardware and monitors |
| 41. | Adelaide | Design of radio frequency systems tags, eg for the Sydney Road Authority |
| 42. | Reynella | Manufacture of electronic components for car manufacturers and also for the telecommunications industry |
| 43. | Rose Park | Design, development and manufacture of electronic metal detectors, ranging from amateur to military applications |
| 53. | Salisbury South | Design of electronic products for customers on a one-off basis |
| 54. | Sheidow Park | Sub-contracted electronics assembly and in-house design of various items |
| 56. | Henley Beach | Design of data logging equipment, mainly for government utilities |
| 58. | Norwood | Design and manufacture of telecommunications equipment to fill niches not covered by Telecom, eg specialised intercom and pager systems |

Source: Data from Questionnaire

### *9.4.3 The Marketing of Products*

Unlike the two previous categories of firms, the main form of marketing for firms in this group is the active seeking out of potential customers. Once the company has identified potential customers, then these customers are

approached by sales representatives, who then try to sell the firm's products and/or expertise. This direct sales approach is used by half of the firms in this group.

"Word of mouth" advertising is still important with eight firms reporting this form of market development. Other forms of marketing used include advertisements in electronics journals (three firms), attendance at various trade shows (two firms) and supplying bids for upcoming tenders (one firm).

## 9.5 PRODUCT DEVELOPMENT

A feature of many high technology clusters containing swarms of small and medium establishments is adaptability and flexibility - the readiness and ease with which firms respond to changing demands. While some establishments constantly try to make their products more attractive to potential customers, others cater exclusively for customers' specific needs through the design and manufacture of individual products to suit particular applications. This second factor has been noted by Oakey *et al* (1988) who found that this was one of the main ways in which high technology establishments could compete in specific market segments.

This was found to be true for an overwhelming majority of establishments in Adelaide. Indeed, 44 per cent of all establishments said that all changes made to their products resulted from the fact that each product was designed and made specifically for an individual customer (Table 11). Frequently these were "one-off" products, although in some cases, after the initial prototypes were made and tested, the products would be manufactured in greater quantities - the actual manufacturing being outsourced to other establishments. One third of the establishments which provide this service are larger establishments, employing

more than 25 people. The remainder are small and medium establishments. These establishments do not produce an in-house line of products. Furthermore such product development projects are very time consuming and many small establishments only complete a handful of contracts per year.

*Table 11: Firms Which Produce "one-off" Products*

| FIRM NO. | PRODUCTS MADE | NUMBER OF EMPLOYEES |
|---|---|---|
| 3. | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post | 140 |
| 4. | Design and manufacture of electronic components and engine management systems | 125 |
| 20. | Manufacture of Printed Circuit Boards | 120 |
| 5. | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) | 75 |
| 7. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | 60 |
| 9. | Design and manufacture of electronic speed controllers for evaporative air conditioners | 50 |
| 29. | Software design; building and testing of various prototypes for the defence industry | 45 |
| 22. | Manufacture of Printed Circuit Boards | 40 |
| 14. | Development of radio frequency technology; systems engineering | 25 |
| 15. | Design and development of computer controlled air conditioning systems for hospitals etc. | 18 |
| 40. | Design of specialised controllers and all associated software | 15 |
| 25. | Manufacture of Printed Circuit Boards | 13 |
| 41. | Design of radio frequency systems tags, eg for the Sydney Road Authority | 12 |
| 16. | Design and assembly of voice and data communication systems | 10 |
| 45. | Production of master compact disks and making of copies | 10 |
| 26. | Manufacture of Printed Circuit Boards | 8 |
| 48. | Manufacture of portable moisture sensors for the agriculture industry | 8 |
| 49. | Development of monitoring equipment for rainfall, water quality etc. | 7 |
| 19. | Design and manufacture of process control instrumentation | 5 |
| 51. | Design of silicon chips and integrated circuits | 5 |
| 54. | Sub-contracted electronics assembly and in-house design of various items | 5 |
| 57. | Design of data logging equipment, mainly for government utilities | 4 |
| 50. | Development of monitoring equipment for rainfall, water quality etc. | 4 |
| 60. | Design work for the Department of Defence; in-house development of defence oriented equipment | 3 |
| 55. | Design of data logging equipment, mainly for government utilities | 3 |
| 37. | Manufacture of computer memories, computer hardware and monitors | 3 |
| 56. | Design of data logging equipment, mainly for government utilities | 3 |

Source: Data from Questionnaire

Schoenberger (1988) has discussed how the essence of flexible competition is flexible and rapid response to changes in the market, whether these result from the behaviour of competitors or from demand shifts. This means that product lines and configurations must be able to evolve more rapidly than was true under Fordism. The importance of flexibility becomes clear on two fronts. Firstly, as discussed above, some high technology establishments manufacture products specifically to suit a particular customer. This requires enormous flexibility on the part of both operator and machinery, especially when projects sometimes vary quite dramatically from one to the next. Most of the products manufactured are patented, and thus they cannot be sold by other companies.

Secondly, 21 per cent of the surveyed establishments make changes to their products simply as a result of market demand, that is, they do not produce a product and hope that a market niche will evolve for it, but rather they try to anticipate the market and then attempt to develop products to suit those needs and wants. Included here are both single-establishment and multi-establishment firms, which vary dramatically in size.

Another major way in which high technology firms change their products in order to remain competitive is to take note of customer feedback and alter and improve products, so that they are more attractive for future customers. The survey revealed that 31 per cent of all establishments made product changes as a result of this process. The most common way in which establishments gained feedback from their customers was through direct contact with the customers following the sale, as part of the establishments' customer support service. A small percentage of establishments posted questionnaires to their customers. It is worth noting that many establishments contacted customers several months following the initial

sale, in order to determine whether customers were satisfied with the performance of the product and what changes would they like to see in a future version.

## 9.6 Difficulties Experienced in Maintaining Forward Linkages

As a result of the highly diverse range of products manufactured by high technology establishments, especially since so many are designed to suit a specific purpose, it is not surprising that some establishments experience difficulties in trying to reconcile their productive capabilities and market demands. The survey attempted to uncover the types of difficulties most commonly experienced by high technology establishments.

Just over half of the surveyed establishments (57 per cent) stated that they had experienced no difficulties in supplying products to their customers and that their customers were generally satisfied with their purchase.

One fifth of the establishments surveyed stated that there were occasions where, following a period of intensive interaction, they simply did not have the technical capability to supply the customer with what was required. In such cases, the customers would usually be referred to another high technology establishment which did have the capability.

Another problem experienced was that often customers would want an establishment to develop a particular product to meet a specific need, but they would be unprepared to pay the full costs involved in the design, development and the ultimate manufacture of that product. Most high technology establishments try to avoid this situation and would rather decline the prospect of gaining a new

contract, than associate themselves with a product which had not been satisfactorily developed.

The survey revealed two other reasons why some establishments experienced difficulties in supplying products to particular customers. Two businesses maintained a policy which would not allow them to deviate away from their core business, that is, there was a limit on the degree of flexibility which these firms would or could accept. One firm was prepared to deal only with a particular group of suppliers, so that if a customer approached the establishment to manufacture a particular product, the contract would be accepted only if components required would be available from the firm's usual suppliers. If components needed to be purchased from other suppliers, then the firm would refuse the particular contract.

## 9.7 CONCLUSION

This chapter has attempted to address the issue of *forward linkages*, and examine how Adelaide's high technology firms interact with their customers. It becomes immediately clear that the high technology firms surveyed are very closely linked with both the local and interstate markets, and that overseas markets are of secondary importance to most firms. Furthermore, it would seem that the significance placed on a given market is dependent upon what the firm actually does or makes.

These findings suggest that high technology electronics firms are indeed well linked into the Adelaide Region, and that the Adelaide Region as a whole is beginning to evolve as a high technology industrial district with a large amount of

interaction occurring both between high technology firms and between high technology firms and other manufacturing industry.

But the interstate market is also important as a destination for high technology products made in South Australia. Fifty eight firms sell at least some of their products to these markets. Whilst firms were reluctant to reveal what percentage of their products were sold locally, as against the percentage sold interstate, many indicated that the interstate markets were of equal, if not greater significance that the local market in the terms of the volume of products sold.

It would seem therefore that the importance of the local versus interstate market varies between firms, depending on what the firms actually do. Those which sell complete products to final demand have a greater reliance on interstate markets. On the other hand, producers of intermediate products place greater emphasis on the local market.

At the moment, overseas markets play a somewhat less significant role in the marketing strategies of high technology firms. The survey revealed that only 24 firms (39 per cent of the total surveyed) have broken into overseas markets, the main ones being New Zealand, Hong Kong, China, South Korea, South Africa, India, Saudi Arabia, the United States, Brazil, Italy, Canada and Finland. Examples of products sold overseas include: electronic speed controllers for air conditioning systems, process control instrumentation, defence oriented equipment, remote roller door controllers, time management clocks, control instrumentation for the mining industry.

In attempting to explain the relative unimportance of overseas markets, many respondents stated that the relative remoteness of Australia and the perceived view of the country as being somewhat of a technological "backwater",

made it difficult for high technology establishments, especially small ones, to gain access to overseas markets. The problem is further exacerbated by the fact that most of the high technology establishments surveyed are relatively small firms, which are not capable of taking large risks and investing in a marketing office overseas. Thus they find that often they are unable to compete on the overseas market or even explore market possibilities from their one office in Adelaide.

Various techniques have also been identified by which high technology firms establish markets for their products, however, as has also been noted in the literature, the most widely used form of marketing/advertising is "word of mouth". Given that the majority of the firms are small and have limited funds for advertising, this procedure is not surprising. The development of a network of satisfied customers is therefore, very important.

The fact that three distinct groups of firms have been identified, namely those which sell only to final demand, those which sell only to other manufacturers and those which sell to both, underscores the wide diversity of products and services which are offered by the high technology electronics sector.

# 10. THE LOCATIONAL ATTRIBUTES OF THE ADELAIDE REGION AS A HIGH TECHNOLOGY CLUSTER

## 10.1 INTRODUCTION

Previous chapters have discussed three of the major determinants affecting the location of high technology establishments, namely the availability of labour, inputs and markets. There are however, a great many more factors which influence a region's ability to attract and nurture the development of a high tech industrial base and some of these are to be addressed in the present chapter.

The aims of this chapter are threefold. The first is to examine, on a macro scale, the suitability of Adelaide as a region for high technology development. The second, on a micro scale, is to analyse the locations of individual high technology establishments within the metropolitan area, to discover whether certain areas are more suited to high technology establishments than others. The third objective is to examine in some detail a location within the metropolitan area which was established with the particular aim of attracting high technology enterprises, namely Technology Park.

## 10.2 THE ATTRIBUTES OF ADELAIDE

Rees and Stafford (1986) conclude that for high technology industries, the attributes of an area are more important than friction of distance considerations, since inputs to the high technology establishments tend to be of high value in relation to transport costs, come from a variety of sources, and markets for high

technology products are extremely scattered. This proposition however may be disputed. The existence of high technology clusters implies that "transport costs" are important. Previous chapters have emphasised the importance of linkages and the need especially to minimise the costs, in the broadest sense, of interaction. However, there is no doubt that many studies have found that the attributes of a region are a critical factor affecting its attractiveness for high technology clustering (Rees and Stafford, 1986; Scott and Storper, 1987). That is, clustering is very important, but so is *where* the clustering occurs. It is therefore necessary to investigate the attributes of Adelaide, and determine to what extent Adelaide does satisfy the needs of high technology establishments.

### *10.2.1 Adelaide's Advantages*

Seven major advantages of a location in Adelaide were isolated and most firms in the study mentioned at least one of these. Five firms noted no particular advantages of being located in Adelaide. These are summarised in Table 12. (For full details, see Appendix E.)

In the United States, Haug (1991) carried out a study of high technology firms in Washington and found that the dominant reason for locating in Washington was that the founders or chief executive officers of the firms already lived in Washington and did not want to move elsewhere. This also proved to be the dominant reason for the location of high technology establishments in Adelaide. The founders of 33 per cent of all establishments surveyed said that at the time of the establishment of the business, they were residents of Adelaide. They set up their businesses where they lived, and had no intention of moving interstate.

*Table 12: Summary Table of the Advantages of Adelaide as a Location for HighTechnology Firms.*

| ADVANTAGE | NUMBER OF FIRMS CLAIMING THIS ADVANTAGE |
|---|---|
| Founders reside in Adelaide and have no desire to move | 20 |
| Quality of life | 45 |
| Strong local defence network | 6 |
| Availability of highly skilled labour | 9 |
| Cheaper to operate business in Adelaide | 19 |
| Access to services is cheaper than interstate | 18 |
| Labour costs lower than interstate | 9 |

Source: Data from Questionnaire

Oakey *et al* (1988) emphasised the importance of the availability of an appropriate workforce in the successful birth and growth of high technology firms, and that many high technology firms require substantial numbers of white collar research and development, but also skilled production, workers. This proved also to be the case in Adelaide, where 15 per cent of the establishments surveyed reported that an advantage of locating in Adelaide was the availability of a good quality labour force. They also noted that labour in Adelaide was considerably cheaper than equally skilled labour in the eastern states. It is very important to note that this does not mean that 85 per cent of establishments found there to be disadvantages in terms of labour in Adelaide, but rather that these establishments did not view Adelaide's labour force as having any distinct advantages over the labour force in other capitals.

Six establishments referred to the fact that Adelaide has a strong defence network and by working in the defence industry, these establishments have access to the specialised inputs and services which they require. The respondents added

that they could not find another location in Australia which was more ideally suited to the types of work which they do. This finding correlates with those of Felsenstein and Shachar (1988), who noted that high technology establishments need to locate themselves strategically, so that they are close to industries which specialise in a similar field of work as the establishment. For example, a high technology firm specialising in defence related work would undoubtedly be at a disadvantage if it located in a region which is predominantly involved in mining - on the other hand a firm which specialised in the design or manufacture of equipment for the mining industry would find such a location highly desirable.

Haug (1991) found that quality of life attributes, transportation services, utilities and land issues, and the quality of educational institutions affects the locational decisions of high technology managers and entrepreneurs, although this assertion was refuted by Galbraith (1985), who placed greater emphasis on profitability. Quality of life was reported by many as an important factor in making Adelaide attractive to high technology firms.

Adelaide is viewed as offering a pleasant lifestyle by 74 per cent of all respondents. The managements of all these establishments could not contemplate living elsewhere. They enjoy the unique combination of living in an environment which offers a relaxed, almost country atmosphere, but together with most of the amenities of a large city.

The lifestyle attributes of Adelaide are important not only to the managers or owners of high technology establishments. In fact, it was reported in a number of establishments that several employees had moved either from interstate, or from overseas, sacrificing higher wages, for a better overall lifestyle.

Employees from interstate are attracted by the fact that Adelaide offers very short travel times compared to Sydney, and that it is possible to live in a rural environment on the fringe of the city and still be within one hour's commuting distance from work. The availability of cheaper housing in Adelaide is also very attractive, compared with the very high cost of comparable housing in either Melbourne or Sydney.

The remaining respondents believed that whilst Adelaide is an attractive city to live in, this alone is not a sufficient reason to locate here. All respondents in this group said that they are located in Adelaide because, at present, the business climate is favourable for high technology establishments, but if this were to change, then they would have little or no hesitation in moving their operations elsewhere.

A further advantage of Adelaide, noted by 31 per cent of all establishments, was the fact that it is cheaper to operate a business in Adelaide compared with Melbourne and Sydney. Factors taken into account here include lower prices for buildings and the lower costs of rent, lower labour costs (which have already been mentioned above) and reduced transactions costs because of shorter travelling distances between firms (so long as those firms with which interaction occurs are located in Adelaide).

Thirty per cent of establishments noted that the costs of services which firms must purchase, are also much lower in Adelaide than in the eastern states. These include legal and accounting services, business services, as well as services associated with the maintenance of various high technology equipment.

It would therefore seems that Adelaide is twice blessed, for not only can it offer the desirable lifestyle and all of the utilities demanded by high technology

firms, but it is also an excellent place to run a high technology business, as all of the major costs are generally lower than interstate.

### *10.2.2 Adelaide's Disadvantages*

Eighteen firms reported no disadvantages of any consequence from an Adelaide location, and could not see how locating elsewhere in Australia would prove to be more advantageous. The remaining 43 firms however, noted one or more disadvantages, which are summarised in Table 13, under five major headings (for full details, see Appendix F).

Given the role of interstate markets (Chapter 9), Adelaide's relative remoteness from these markets, predominantly Sydney and Melbourne, proved to be one of the major disadvantages for high technology establishments, with 47 per cent of all respondents commenting on the small local market in Adelaide, and the problems associated with trying to sell products on distant markets. This finding is in direct contrast with Rees and Stafford's (1986) conclusion presented earlier in the chapter.

A study of high technology companies in the United Kingdom (Howells, 1984), found that being located close to an international airport (and particularly Heathrow) was an important locational factor. While Adelaide does have an international airport, 44 per cent of establishments found the number and frequency of international flights to and from Adelaide and their limited connections, were a disadvantage, compared for example, to Sydney and Melbourne. This situation makes it difficult for those establishments which export at least some of their products overseas (a total of 30 per cent of all establishments surveyed), as

they are frequently forced to ship their goods interstate, before they can be exported from the country.

Also described as a problem by 44 per cent of respondents was the difficulty of travelling to interstate business meetings from Adelaide, because of the relatively small number of flights interstate, and the frequent need to have to spend time in transit waiting at another airport for a connecting flight. This is especially the case for those establishments which need to interact with other establishments or organisations in Canberra (defence related establishments). There are very limited flights to Canberra from Adelaide, and almost all travel via Melbourne, thereby markedly increasing travelling time. Furthermore, respondents stated that because of such a limited connection, an overnight stay is often required in Canberra. Once again, this causes inconvenience and increases costs unnecessarily, especially for a small firm whose owner/operator has to be multifunctional. It is worth mentioning that it is not the monetary cost of distance which is the problem, but the *time and inconvenience*. Also, face to face meetings interstate are viewed by the respondents as disruptive, and no doubt such meetings would be held more frequently, if it were not for this factor.

*Table 13: Summary Table of the Disadvantages of Adelaide as a Location for High Technology Firms*

| DISADVANTAGE | NUMBER OF FIRMS CLAIMING THIS DISADVANTAGE |
|---|---|
| Lack of adequate airport services | 19 |
| Expensive to source components from interstate | 10 |
| Small local market | 20 |
| Lack of local expertise in the provision of service facilities | 7 |
| Remoteness from the major markets of Melbourne and Sydney | 24 |

Source: Data from Questionnaire

Another disadvantage (noted by 23 per cent of the surveyed establishments) already discussed in Chapter 8, is lack of access to imported parts and components. The main distributors for these components are frequently located in either Sydney or Melbourne and thus there is a need to have them shipped to Adelaide. This increases delivery time and also adds costs which are ultimately passed on to the consumer in the form of a more expensive product. Once again, perhaps more important than actual cost is the problem that the componentry is often very specific and it is a disadvantage if there cannot be close contact for multiple feedback.

A final disadvantage noted by 16 per cent of respondents is the lack of local expertise in the provision of service facilities. Firms noted that they were unable to obtain service on particular equipment in Adelaide and that the equipment would have to be shipped either interstate to Melbourne or Sydney for repairs, or alternatively be shipped overseas to the original manufacturer, as the expertise required to service such equipment simply does not exist in Australia. Other problems with servicing or repairing equipment include the need to 'import' technicians from interstate or overseas, or the need to replace equipment once it breaks down, as it is too costly, time consuming and disruptive to have it repaired.

### *10.2.3 Possibility of an Interstate Location*

A location decision is almost always a trade-off between conflicting forces, so that despite the above-mentioned disadvantages, 82 per cent of respondents stated that they would not consider moving to another capital in Australia, as the advantages of both living and operating a high technology business in Adelaide far outweigh any disadvantages. In fact nearly all of these respondents said that there

would probably be more disadvantages from a business point of view of operating in either Sydney or Melbourne than there would be advantages. This is an important point when analysing questionnaire responses. Some of the advantages of a Sydney location, such as a well connected international airport and larger market, are accompanied by disadvantages such as high real estate prices, long journeys to work and congestion.

Although only one establishment had recently moved from Sydney to Adelaide, information from this business provides valuable insights. The main reasons for the move were that operating a small establishment in Sydney is very expensive and there is a need to do far more business than in Adelaide in order to return the same profits. Furthermore, and in support of much of the literature on the locational preferences of high technology establishments, the owner of the establishment wanted to improve his overall lifestyle, and live in a more pleasant environment, away from the so-called "rat-race" which is typical of larger cities.

Only 26 per cent of all establishments surveyed said that the eastern states were a viable locational alternative to Adelaide, and that from a business point of view, probably better. The eastern states are viewed as being closer to the world market for high technology products and are perceived as the centre of high technology research and development, and so the synergies, so essential to high tech growth, are supposedly greater. Furthermore, these respondents also felt that by locating in Adelaide, they were being overlooked by many potential customers from overseas, as Adelaide is not perceived, from abroad, as being a corporate headquarters, so that overseas customers tend to overlook Adelaide in favour of Melbourne and Sydney.

On the other hand, 72 per cent of establishments surveyed stated that they could see no benefit in moving to another location and that if they moved interstate, costs of running the business as well as costs of living would increase substantially and they would probably negate any additional profits made by the establishment. Also, the management would have to look for new employees, as the majority of the present staff would be unwilling to move.

### *10.2.4 Government's Role in Making Adelaide More Attractive to High Technology Establishments*

Many would argue that governments have an important role to play in making a location more or less attractive for high technology development. Haug (1991) found that a state's tax climate and pro-business attitudes had a bearing on high technology development and that small high technology establishments were influenced more by government policies than large, multi-establishment firms. Table 14 shows some of the ways in which high technology establishments believe the South Australian Government could make Adelaide a more attractive environment for high tech development. Over half the firms thought that there was in fact very little the Government could do to improve the local environment for high technology industry.

*Table 14: Ways in which S.A. Government can make Adelaide more Attractive to High Technology Establishments*

| WAYS TO MAKE ADELAIDE MORE ATTRACTIVE TO HIGH TECHNOLOGY ESTABLISHMENTS | PERCENTAGE OF ESTABLISHMENTS AGREEING WITH THIS VIEW |
|---|---|
| Provide support for establishments who wish to expand | 15% |
| Reduce 'petty taxes' eg. FID; BAD | 13% |
| Create a better economic climate, more conducive to small businesses | 8% |
| Provide tax concessions for establishments which need to import equipment | 7% |
| Improve interstate transport links & give preference to local firms before looking overseas | 3% each |
| None | 56% |

Source: Data from Questionnaire

## 10.3 THE LOCATIONAL PATTERN OF HIGH - TECH ESTABLISHMENTS WITHIN THE METROPOLITAN AREA

The previous section examined the attractiveness of Adelaide for high technology electronics firms at the macro scale. Attention now shifts to location at the micro scale. Chapter 6 identified two high technology clusters in the Adelaide Region - a Central Region in and around the CBD, and a Northern Region comprising firms mainly at Technology Park. The decision to locate in Technology Park, away from the CBD, will be examined later. Attention will be directed firstly to businesses outside the Park.

### *10.3.1 Establishments Located Outside Technology Park*

The location of the individual establishments was assessed by asking the founders or managers what they perceived to be the main advantages and disadvantages of their location.

#### 10.3.1.1 Advantages of the Present Location

Table 15 summarises the advantages of the present locations of the high technology establishments within the metropolitan area under seven main headings. A number of issues arising from the table require discussion (for full details, see Appendix G).

The vast majority of establishments have noted the importance of being located close to the city. A central location is viewed as essential not only for the access to other businesses, which such a location provides, but also for its ability to attract the necessary employees. There is a strong perception among high technology managers that employees would be reluctant to travel longer distances to work. By choosing a central location the business has access to a high

technology labour market which extends across the metropolitan area and beyond. Any other location would tend to reduce the size of the potential labour market area.

*Table 15: Summary Table of the Advantages of Firms' Present Location in Adelaide*

| ADVANTAGES OF THE PRESENT LOCATION | NUMBER OF RESPONDENTS STATING THIS ADVANTAGE |
|---|---|
| Close proximity to airport and city | 31 |
| Close to place of residence of managing director | 16 |
| Close to various suppliers | 26 |
| Modern buildings and good facilities at reasonable cost | 23 |
| Room for future expansion | 10 |
| Company owns the site and it is too costly to move | 11 |
| Close to : Parent Company<br>University | 1<br>4 |
| High-Tech Image | 10 |

Source: Data from Questionnaire

This supports the finding of Malecki (1991), who states that research and development workers are highly mobile, but at the same time they are willing to live only in areas with high amenity value. By locating close to the city, high technology establishments maximise their ability to attract employees with the necessary skills and qualifications, as a central location will ensure that such employees will never have to travel great distances to work. Conversely, the firm has access to a labour supply from a range of residential environments, as diverse as the hills, the coast, wine growing regions or inner city town houses.

Furthermore, the main customer base for high technology establishments in Adelaide is in and around the city, and many managers consider that not to locate

within this area, would reduce their ability to attract business, as potential customers would be unwilling to travel into the suburbs, when they could purchase similar goods or services from competing establishments closer to the city. It will be recalled that word of mouth and face to face contact are the most important vehicles for transmitting information.

By locating close to the city, high technology establishments are also within a short distance of the airport, which is viewed as being important. Close proximity to the airport means that courier costs are kept down and perhaps more important, goods can be shuttled quickly in order to be delivered promptly. The importance of the location of an airport for high technology establishments, for both the movement of products and also for the ability of company executives to travel quickly interstate, has also been noted by Howells (1984).

A total of 22 per cent of the establishments which are outside Technology Park, but away from the central business district, noted that the current premises had modern facilities, allowed room for expansion and were available at reasonable cost. Thus it seems, just as Howells (1984) proposed, the right type of premises is important in a high technology establishment's choice of location. However, as previously observed, it is likely that this is a necessary, but on its own, not a sufficient factor of location. The "right premises" may be available in many regions. The cost factor may be more significant, with businesses away from the CBD trading off increased transaction costs for lower land and building costs.

Howells also noted that high technology establishments found it important to be located close to the establishments' main headquarters. This did not seem to be of such great significance in Adelaide, as only one establishment (out of a

total of 17 multi-establishment firms) reported that it is located next door to its parent company as this is very important for its research and development work.

The present study revealed that only four high technology establishments considered that the main advantage of their current location is its proximity to an Adelaide university. This might suggest that high technology establishments (located outside Technology Park), are indifferent to the location of a university when they chose their current locations. But a more likely explanation is that any location around the CBD, in a city the size of Adelaide, would be in close proximity to a University campus

Vaughan and Pollard (1986) have noted that universities are a prerequisite in sustaining a concentration of high technology establishments, and Rees and Stafford (1986) go further and stress the importance of nearby colleges and universities to high technology establishments. As has been demonstrated in Chapter 7, over one-third of high technology firms in Adelaide have some if not all of their research and development work undertaken at one of Adelaide's three universities, as well as seeking advice from universities on particular aspects of research and development work. Perhaps this is why, unlike their overseas counterparts, high technology firms in Adelaide, do not place great emphasis on informal ties with academia, which may result in the birth of new ideas. Although it is not certain that physical proximity is necessary for such informal ties to develop, the separation of industry and academia no doubt prevents the development of such informal dialogue. Perhaps the most likely explanation however, is that Adelaide firms "take for granted" the presence of these institutions and so do not remark on them. The fact is that a location almost anywhere in Adelaide's

metropolitan area would not involve a massive separation from a university or TAFE college.

The study also revealed that 46 per cent of high technology firms in Adelaide find it advantageous to be located close to at least some of their suppliers. This is more important for those firms which actually make a product, rather than for those which are involved in only the design or development of new products or the provision of various services.

The residential location of the managing directors and owners of high technology firms also has an effect on the location of high technology firms. The study has found that 16 managers/owners have located their firms close to their place of residence, so that they will not have to travel long distances to work. In only a few cases however, did this prove to be the sole reason for the location of the firm in a given area. In most cases, other location factors had a far greater influence on the location of the firm.

#### 10.3.1.2 Disadvantages of Present Location

Only 25 firms out of the total 61 could point to any particular disadvantages with their current location. Indeed, only 13 firms outside Technology Park were dissatisfied with some aspect of their location. Table 16 summarises the disadvantages which firms noted about their current location under seven main headings. The table lists only those firms which expressed dissatisfaction with their location in any way (for full details, see Appendix H).

Only six out of some 35 firms located within the Central Region expressed some dissatisfaction, suggesting the overall attraction of this location. And as

might be expected in and around the CBD, for four of these the problems related to old, small and confined premises.

*Table 16: Summary Table of the Disadvantages of Firms' Present Location in Adelaide*

| DISADVANTAGE OF THE PRESENT LOCATION | NUMBER OF RESPONDENTS STATING THIS DISADVANTAGE |
|---|---|
| Premesis too old and too small; no room for expansion | 11 |
| Remote from the city and the airport - takes longer to get to meetings | 6 |
| Rent very expensive for the poor quality of premises | 11 |
| Isolated from other businesses, eg. banks | 1 |
| Located too far from the city; many customers do not want to make the trip | 1 |
| Frequent legal problems with Local Council | 1 |
| Business located on main road - too much noise and pollution | 1 |

Source: Data from Questionnaire

In the Northern Region, all but two firms located at Technology Park complained that the accommodation was of poor quality in comparison to the amount of rent which they had to pay. Many commented that they would be able to find much more upmarket premises, closer to the city, for a lot less. Five out of the 12 firms located at the Park also complained about the Park's remoteness from the CBD. The remaining two firms in the Northern Region (outside Technology Park) did not find any real disadvantages of their present location.

Seven out of the 12 firms located outside the two main clusters stated that their main locational disadvantage was old premises, which did not allow room for expansion.

#### 10.3.1.3 Prospects of Moving to Another Location

Because of the high level of satisfaction with the present location, it is not surprising that 61 per cent of firms have never considered a move. Of those for whom a move was a possibility, 16 per cent said that this would be when their current premises became too small, although they had not given much consideration to an alternative location; 10 per cent would probably relocate to Technology Park; eight per cent would move closer to the city.

#### 10.3.1.4 Perceived Advantages of Being Located at Technology Park

Over the past few years, Technology Park has received considerable attention from the mass media, and popular press, and the State Government has underlined the Park's importance in the quest towards making Adelaide 'the clever city'. Further, the Park has come to be seen as central to the development of the Multi-Function Polis concept.

Only two positive attributes of a Technology Park location were noted by a small minority of establishments located *off* the Park. First, three establishments believe that locating at Technology Park would probably prove advantageous because the Park environment allows for good synergy to develop as a result of so many innovative firms being located together. It allows for the useful exchange of information between different firms, resulting in an increase in innovation. This view is supported by Malecki & Nijkamp (1988), who also note that high technology establishments find it advantageous to be part of an industrial complex, facilitating external economies and benefiting all participants by proximity to a common resource pool of new ideas, on which all may draw. Of course, location on a Technology Park is not necessary for this to occur and firms located in the Central Region benefit in this way. Second, a further three managers recognise that a

technology park address may present an advantageous image, especially in dealings with overseas customers, who may otherwise bypass high technology establishments in Adelaide, in favour of those located in Melbourne and Sydney.

The study also explored the possibility that the very fact that a technology park exists in Adelaide influences other high technology establishments, even though they are not located on the Park itself. While 73 per cent of establishments stated that they saw no benefit from the Park, the remainder believe that the Park is responsible for attracting high technology organisations into the state and thereby allowing existing establishments to interact with them. Furthermore, Technology Park is believed to nurture high technology growth within the state and this leads to spin-offs for other establishments. In other words, Technology Park is perceived as stimulating a process of positive feedback, which ultimately results in an increase in innovation in the state through the attraction of interstate and overseas enterprises.

This finding supports Fingleton's (1992) assertion that the presence of an high technology establishment will increase the chances that the next etablishment will locate nearby. The greater the agglomeration, the greater its powers of attraction. Once again, such an agglomeration does not require a technology park, as has been shown by the 49 establishments located off the Park.

#### 10.3.1.5 Perceived Disadvantages of Being Located at Technology Park

As mentioned earlier, 49 out of the 61 establishments surveyed in this study (80 per cent), chose to locate outside of Technology Park. This suggests that the majority of establishments perceive certain disadvantages or limitations in locating at the Park itself. The 49 establishments located outside Technology Park were

questioned about their perceptions of the disadvantages of a location at Technology Park. Six of the 49 businesses had in fact considered such a location and clearly, making the decision they had made, they must have calculated that the disadvantages outweigh the advantages.

The main disadvantage, noted by 65 per cent of all establishments external to the Park was the high rent, which was considered prohibitive for small establishments. Many respondents commented on the fact that that they would be able to rent far more attractive premises within the Adelaide CBD, for approximately half the cost of rent at Technology Park. They noted that these high costs easily negated any advantages of locating at Technology Park.

Another perceived disadvantage of Technology Park (noted by 55 per cent of establishments located off the Park) is its remoteness from the city and also from the airport. As Table 16 shows, a location close to the city is considered necessary for 57 per cent of all establishments, as this is where the main customers, services and sources of inputs exist. Proximity to the airport is advantageous for interstate and overseas business trips, for acquiring components not available locally and also for export purposes. Six establishments also felt that because Technology Park is not located centrally in Adelaide, it would be less able to attract the necessary personnel. Only two establishments felt that there would be no disadvantages of locating at the Park.

### *10.3.2 Establishments Located at Technology Park*

Only 12 establishments, representing 20 per cent of the total surveyed, were located at Technology Park. Of these, ten have been at the Park from their conception, one had moved from Sydney to Technology Park in the 1980s, and

another began as a small high technology business in the home of the founder and later moved to Technology Park, when the business expanded, and additional employees were taken on. The study aimed at discovering why these establishments have decided to locate at Technology Park, and whether the Park has lived up to its advertised claim of creating an environment conducive to high technology development.

#### 10.3.2.1 Advantages of Being Located at Technology Park

The main advantage was seen to be the image and prestige associated with a location or a place called "Technology Park". Six managers said that this was the only reason they remain at the Park, for image is perceived to be very important, especially when dealing with overseas customers. This may well be an important factor when establishments from Adelaide are competing for an overseas contract, against other, better known enterprises.

Few other advantages of any real consequence were noted. One manager said that it was convenient to be located "across the road" from the University of South Australia, Levels Campus, as the establishment frequently contacts the university for advice and assistance with various research and development projects. Another manager, who cooperates closely with the defence industry, stated that being located within a 20 minute drive from the Defence Science and Technology Organisation at Salisbury meant that it was easy and cost efficient to cooperate with the DSTO, which was often necessary, especially when the establishment was working on a project for the DSTO.

Respondents were also asked about the existence of *agglomeration economies* which are often used as a major justification for Technology Parks.

Seven establishments commented favourably, saying that they frequently work very closely with a number of different establishments on the Park, and that this is one of the primary reasons why they elect to remain at Technology Park, regardless of other obstacles. Such *agglomeration economies* are viewed as being important for a healthy high technology industry by Hagey & Malecki (1986), who stress that an important form of communication between high technology establishments is face to face contact, often involving the technical personnel of buying and supplying establishments.

One manager stated that he has developed business relationships with other establishments on the Park, but because of the specialised nature of the business, these relationships would have been forged, irrespective of the location of the other establishments. Four other managers stated that because of the nature of their work, they have never had a need to develop any relationships with other establishments located at the Park.

#### 10.3.2.2 Disadvantages of Being Located at Technology Park

Respondents pointed out a number of disadvantages of locating at Technology Park. Excessive rental charges proved to be the most highly disliked attribute. Nine managers said that if the costs increase any further, they will very seriously consider moving elsewhere, as these costs outweigh any benefits offered by the Park environment.

Markusen *et al* (1986) found that high technology establishments find it advantageous to be located close to support companies, offering marketing, accounting, consulting and financial services, as frequently the founders of high technology establishments lack the necessary skills to operate these aspects of

their businesses efficiently. In this respect, Technology Park, or rather its physical location, lacks proximity to nearly all of these services. All the establishments surveyed at the Park reported that if they need to consult one of these service providers, they usually have to travel into the city. This is time consuming, as repeat visits are usually necessary, and tends to reduce the quality of the interaction.

Five firms at Technology Park also complained that the Park was too remote from the city centre and the airport. This increases travelling time to the city for meetings and also increases courier costs when items need to be sent by plane. Only one firm outside Technology Park noted this problem. Furthermore, the distance from the city to Technology Park means less access to the courier network. Respondents stated that it is usually impossible to arrange more than one pick-up or delivery in one day, and bookings have to be made very early, otherwise the items which need to be sent have to wait until the next day. This contrasts sharply with the situation of those establishments located in or near the city, where courier services can be arranged almost instantly.

Two managers claimed that they failed to find any advantages in being located at Technology Park, and after a period of a few years, have decided to move into the main agglomeration of high technology firms in the Central Region. These respondents believe that they can run their businesses just as efficiently off the Park, without having to incur the high rent costs.

## 10.4 Conclusion

This chapter has examined the location question at two levels, firstly the attractiveness of Adelaide to high technology firms and then the location patterns at the intra-metropolitan scale. Two distinct regional clusters are apparent, the

Northern Region, centred on Technology Park, and the Central Region in, and adjacent to, the City of Adelaide.

The majority of high technology establishments have chosen a location away from Technology Park. In fact, they have moved into the old traditional industrial districts of inner Adelaide and the city itself, which over the past few decades have undergone extensive gentrification. Most of these managers are very satisfied with their location. Being close to the city also means being close to their main customers, input and service suppliers, while access is also facilitated for their employees. The majority of establishments located away from Technology Park do not contemplate moving there, the main disadvantages being its remoteness from the city and also the perceived high rental costs. However, even establishments located off the Park believe that it is responsible for attracting high technology innovative firms into the state and this allows the exchange of ideas, which is so important to the survival of any high technology industry.

Only one-fifth of the establishments surveyed for this study are located at Technology Park. These establishments see the most important benefit as the 'high tech' image which it promotes. They also see the importance of the agglomeration economies at Technology Park, as being fundamental to the running of their businesses.

The high rental costs of Technology Park were put forward as being the main disadvantage of locating at the Park. It would seem that this is an area which the State Government, if it is serious about attracting high technology enterprises to Adelaide, should address.

The study revealed that Adelaide as a whole has an ideal environment for high technology enterprises, offering a very pleasant lifestyle, with all the amenities of a large city, although with far lower costs compared to Melbourne or Sydney.

# 11. SUPPLIERS TO HIGH TECHNOLOGY FIRMS IN ADELAIDE

## 11.1 INTRODUCTION

The preceding chapters have focused on the nature of high technology firms in Adelaide, their links with the South Australian economy and their locational preferences. The firms discussed in those chapters were providers of high technology goods and/or services. There is however, another group of firms which, although not high tech in themselves, are nonetheless intimately linked with the high technology industry. These are the local suppliers of high technology components. The importance of having local suppliers has been discussed at length by Hagey and Malecki (1986), who found that high technology firms not only require telephone contact with the suppliers on a regular basis, to ensure that goods are delivered on time, but also that they often need to evaluate a supplier's products or to resolve various design problems. Both of these require interpersonal consultation between the technical engineers of the given firm and the suppliers. It is therefore often advantageous for both the high technology firms and the suppliers to be located in reasonably close proximity to one another.

This chapter therefore, examines the suppliers of high technology electronic components in Adelaide. An assessment is made of the nature and location of these firms, where they obtain their components, who are their major customers, and what is the relationship between the suppliers and the high technology firms themselves, examined earlier in this study.

## 11.2 SINGLE-ESTABLISHMENT SUPPLIERS

Three of the five suppliers surveyed were single establishment firms. The firms were established in 1968, 1990 and 1991 respectively. The founder of one of the supplier firms had worked in the electronics industry, and had experienced first hand the difficulties of having to order components from interstate, or directly from overseas. The latter proved especially difficult for the small high technology firm. Most overseas suppliers are reluctant to fill orders for only a few components. In most cases, they supply components in boxes containing several hundred or even several thousand. Such quantities, apart from being unnecessary, are also usually beyond the financial means of small high technology firms. A supplier on the other hand, has the ability to purchase large quantities of particular components and then sell them to small firms a few at a time.

A second component supply firm was established when two employees of a prominent electronics company decided to leave, and establish their own component supply and distribution firm. This occurred after the firm which they worked for changed direction and moved away from supplying and distributing electronic components and began to concentrate on the repair of electronic equipment. The two founders saw a potential gap being created in the market and decided to establish a business to fill that market need.

The third single-establishment component supply firm was initially established as a small high technology firm which developed and installed telephone systems which required a memory. The owner of the firm saw the potential to increase turnover dramatically by importing and distributing electronic components. Over time, the business changed direction, and now concentrates on the supply of electronic components.

### *11.2.1 Profile of Founders and Their Motivations*

The founders of component supply companies compare favourably, in terms of education and previous work experience, with their counterparts who have established high technology firms. One founder is a Radio Engineer, who had also worked as an engineer in a major Australian electronics manufacturer and had completed a Diploma in Business Administration. The two founders who spun-off from the major electronics company both had sales training and limited technical knowledge, whilst the founder of the third firm holds an Associate Diploma in Mechanical Engineering and for many years had worked as the service manager of the Adelaide branch of a multinational electronics firm.

The motivations to establish a component supply company also vary amongst the three founders. One firm was established to serve the local electronics market at a time when access to electronic components, especially in Adelaide, was very restricted. The inability to gain employment for nearly two years, following retrenchment from a previous job, motivated another founder to establish a component supply business. The founder's previous work experience and contacts within the electronics industry proved invaluable in establishing the component supply firm. The third business was established out of a desire by the partners to operate their own business, but to stay within the electronics industry. Since they did not have any formal training in electronics, but a wealth of sales experience, they moved into the electronics component supply business, where they are involved essentially in sales of components.

Four inputs were mentioned by all founders as being necessary for the establishment of an electronic component supply business. First, educational

qualifications; second, access to electronic components, and knowing where to purchase them at the most competitive prices; third, capital to establish the business and to purchase stock (which can be quite considerable); fourth, an intimate knowledge of the electronics trade and contacts with potential customers.

## 11.3 MULTI-ESTABLISHMENT FIRMS

Two of the surveyed suppliers are branches of multi-establishments firms. One firm is a branch of a multinational, United Kingdom-based organisation, which has its Australian headquarters in Sydney. The other firm is part of a national organisation, which is headquartered in Melbourne. The parent companies of both these firms operate branches in all major Australian capitals.

While the branch of the Australian based firm is undifferentiated from its other branch plants, in that all the branches distribute only components purchased from a third party, the Adelaide branch of the multinational organisation differs from those interstate. All other Australian branches are, in effect, manufacturing plants, which specialise in the manufacture of particular components. The Adelaide branch acts as the organisation's Australian distribution centre, and as such, performs no manufacturing operations at all. It is unfortunate that the interviewee did not know why the parent company in the United Kingdom had chosen Adelaide as the main distribution centre.

## 11.4 THE LABOUR FORCE

The firms surveyed employed ten, five, four, three and two people respectively. With the exception of reception staff in the two largest establishments,

all of the other employees are involved directly in the sales and distribution of electronic componentry. In general the employees have TAFE diplomas in electronics and, in two instances, also sales training.

The main type of work performed by employees of component suppliers is the sale of components directly to customers or the processing and shipping of orders. Only one firm goes beyond sales and provides a component customising service, whereby if components to fulfil a certain task are not available on the market, the firm will customise existing components to suit a customer's specific needs.

Four of the firms surveyed stated that they had little or no difficulty in finding the right employees locally. One firm however, noted that although it was easy to find people who have electronics knowledge, they frequently lacked sales skills and experience. The employees were eventually recruited locally, but the process took some time. All of the owners/managers of the firms surveyed said that their employee turnover was "very low".

## 11.5 THE IMPORT AND MARKETING OF COMPONENTS

### *11.5.1 Types of Materials/Components Purchased and Their Origins*

The types of materials and components purchased from manufacturers are varied, although the components which are stocked is determined by demand. If there is no demand for a particular component, then it will simply not be stocked. The main types of components purchased by suppliers include: resistors, plain circuit boards, electronic switches, memory boards, capacitors, silicon chips,

switches, motherboards, videocards, controller cards, monitors and power supplies.

Three suppliers import their components directly from overseas manufacturers. The remaining two firms purchase components from wholesalers and distributors both overseas and interstate. Components are sourced from a variety of different regions in the world. While those from Asia are frequently cheaper than their counterparts from the United States or Britain, many suppliers have commented on the fact that they are also of poorer quality. Table 17 lists the main countries from which components are sourced and the number of component suppliers purchasing from those countries.

*Table 17: The Origins of Components*

| ORIGINS OF COMPONENTS | NUMBER OF FIRMS PURCHASING FROM GIVEN REGION |
|---|---|
| Korea | 4 |
| Taiwan | 4 |
| United States | 4 |
| United Kingdom | 4 |
| Malaysia | 3 |
| Japan | 2 |
| China | 2 |
| Australia | 1 |

Source: Data from Questionnaire

Three of the five suppliers surveyed sell components which are readily available. One firm sells some specialised components, which are difficult to obtain without the right contacts, whilst the remaining firm specialises in the import and sales of components which are made by companies for which it is the sole South Australian agent.

### *11.5.2 Marketing and Sales of Components*

All five firms surveyed sell their components directly to their customers, without relying on any third party distributors. Three firms stated that they have a regular core of customers, on which they rely quite heavily for constant repeat business, while the other two serve a diversity of customers and also many 'one-off' customers. These firms have a much wider customer base, ranging from hobbyists, through to electronics repairers and high technology establishments.

Four of the firms surveyed only resell electronic components to their customers, without offering a customising service. As discussed earlier, one establishment however, will customise components to suit a customer's specific requirements. Two of the firms surveyed provide very little customer service in terms of offering advice to potential customers. These firms function along the lines of a 'mail order service', whereby customers simply order the components they need and these are delivered in due time. The other three firms however, provide a consulting service, whereby they discuss individual customers' needs and then advise on the best components for that particular application. This is especially the case for the firm which customises components, as some components can be more readily customised than others.

Very few difficulties were reported which affected the firms' ability to supply components to customers. The two problems worth mentioning include the fact that customers often want their components customised to suit particular applications. Since four of the five firms do not offer such a service, customers frequently have to be directed to another supplier or alternatively, they must settle for a commercially available component from that particular firm. Second, components tend to become obsolete very quickly, and suppliers frequently have

difficulty in finding substitute components for those which they sold three or four years previously.

The main way in which customers learn about the suppliers is through "word of mouth". In this respect, the suppliers vary little from their high technology counterparts, who also rely heavily on this form of advertising. Customers are also made aware of the suppliers' existence through limited advertising in selected electronics journals.

## 11.6 THE LOCATION OF ELECTRONICS SUPPLIERS

Figure 1 (p. 92) shows the location of electronics suppliers in Adelaide in relation to high technology establishments. The importance of the City of Adelaide, and the surrounding inner suburbs as a high technology hub, is underscored by the fact that three out of the five suppliers are located in the square mile of Adelaide, and one is located on the fringe of the city at Norwood. All of these suppliers find it advantageous to be close to the city centre, which is where their main customers are located. One supplier is located at Enfield, which is not too far from the city, but at the same time reasonably close to Technology Park, which allows the firm to attract business from high technology establishments located at the Park. None of the suppliers noted any disadvantages of their present location, although those located within the city said that a lack of available parking spaces was a problem.

### *11.6.1 Adelaide's Locational Advantages and Disadvantages*

When considering Adelaide as a location for electronics suppliers, only one firm said that it had considered moving interstate, as that is where the majority of

high technology electronics business exists. Two firms perceived there to be no particular advantages of being located in Adelaide. The others noted the advantages of Adelaide as being the ease of moving imported components into the state, because of the small amount of customs traffic at Adelaide's airport and docks, and the fact that there are many small high technology electronics establishments in Adelaide. It is these small firms which account for the majority of the customers on which the electronics suppliers rely. The remaining respondents found little difficulty in accessing components locally.

The lack of a large local market proved to be the major disadvantage for electronics suppliers located in Adelaide (as was also the case with high technology establishments). This was exacerbated by the fact that though Adelaide is not a "branch plant economy" the few multi-establishment high technology firms, who have their headquarters interstate, must rely on head office to source all the necessary parts and components. In the instances where head office is interstate, then suppliers located in that state will usually be chosen in preference to those located in Adelaide. This circumstance really underscores the importance of Adelaide's high technology electronics sector *not* being a branch plant economy. However, it was suggested that many small high technology establishments automatically look interstate and overseas for inputs, neglecting services which may well be available locally.

Another problem caused by the small local market is the fact that local suppliers must sell their products interstate to supplement their local business. There is something of an irony here. Local suppliers cannot sell enough components to the Adelaide market in order to survive, thus they must look to interstate markets for additional business. On the other hand, local high technology

establishments, instead of supporting the local suppliers, purchase a vast amount of components directly from interstate, even though they often could be obtained through local suppliers.

Electronic component suppliers placed no emphasis on the quality of life offered by Adelaide. While they all agreed that Adelaide offers a pleasant lifestyle, their sole reason for locating in Adelaide is that the owner/founders of the firms live here and moving would be an expensive exercise.

Two of the firms surveyed stated that moving interstate would be a positive step for the business, as there is a greater concentration of high technology activity in both Melbourne and Sydney. The other three firms noted that while the business opportunities may be greater, so are the costs of living and of running a business. In this respect they feel that an interstate move would prove of little benefit. The findings for high technology establishments were similar, with only one-quarter of them believing that an interstate move would prove to be beneficial for their business.

### *11.6.2 Component Suppliers and Technology Park*

Only one of the firms surveyed noted that it had considered moving to Technology Park. The respondent felt that the Park was a developing hub of high technology electronics activity and by moving there, the firm would be able to optimise its business potential. The remaining four firms could not perceive there to be any advantages in moving to the Park. As they all deal with one or more customers at the Park, they could not see how moving there physically could improve the situation. If anything, they believe that it could have a negative effect on their business, as they would be removing themselves away from the main core of

their customers, located in and around the city itself. Furthermore, the costs of accommodation rental at the Park are much greater than they are elsewhere, and any additional business would not compensate for this.

On the positive side however, all of the firms see Technology Park as being important to the attraction of high technology establishments into the State. The greater the number of establishments entering the State, the greater the potential for suppliers to attract more business. The Park also attracts electronics graduates from interstate. This makes it easier for component suppliers to find employees.

## 11.7 CONCLUSION

This chapter has focused on a neglected aspect of high technology networks, namely the role played by electronic component suppliers. As the study has shown, suppliers in the Adelaide context, may be either single or multi-establishment firms, which generally specialise in the distribution and sales of components manufactured by other companies, frequently overseas, although in one instance, the components are manufactured in Australia. There is however, one exception, namely a firm which also customises components to suit customers' particular needs.

The actual links between component suppliers and high technology establishments in Adelaide are rather poor. On the one hand, from the high technology establishments' point of view, local component suppliers are utilised for some inputs, but many others have to be purchased either from interstate or directly from the manufacturers, mainly overseas, as they are not available locally. This would seem to imply that local suppliers do not stock a wide diversity of components, or that having components available locally increases costs, and

hence high technology establishments look elsewhere for the majority of their inputs.

On the other hand, local component suppliers' stocks are demand driven; they stock those components which local establishments buy and those which no one wants are simply not stocked. Furthermore, in order to exist, suppliers are forced to sell to interstate markets, as there is not enough local demand.

It seems therefore that there is a lack of dialogue between high technology establishments in Adelaide and the local electronic component suppliers. If high technology establishments made it clear which components they need, negotiated a mutually agreed price and made a commitment to purchase those components, then undoubtedly, the local suppliers would do their utmost to satisfy their customers.

# 12. CONCLUSION

The thesis began with a question *"is Adelaide the right place at the right time so far as the development of the region as a high technology industrial district is concerned?"* The nature of the study, examining only a part of the high technology sector, namely the electronics industry, does not permit a firm conclusion. It is possible however, given the data collected, to compare and contrast the Adelaide Region with the two traditional bastions of high technology development - Silicon Valley in California, and Route 128 in Massachusetts - to see if there are any lessons to be learned as Adelaide strives towards becoming Australia's 'clever city'.

Saxenian (1994) compared in great detail Silicon Valley with Route 128. Briefly, she discovered that Silicon Valley has a regional network-based industrial system that promotes collective learning and flexible adjustment among specialist producers of a complex of related technologies. The region's dense social networks and open labour markets encourage experimentation and entrepreneurship. Companies compete intensely while at the same time learning from one another about changing markets and technologies through informal communication and collaborative practices; and loosely linked team structures encourage horizontal communication among firm divisions and with outside suppliers and customers. The functional boundaries within firms are porous in a network system, as are the boundaries between firms themselves and between firms and local institutions such as trade associations and universities.

The Route 128 region, in contrast is dominated by a small number of relatively integrated corporations. Its industrial system is based on independent

firms that internalise a wide range of productive activities. Practices of secrecy and corporate loyalty govern relations between firms and their customers, suppliers and competitors, reinforcing a regional culture that encourages stability and self-reliance. Corporate hierarchies ensure that authority remains centralised and information tends to flow vertically. The boundaries between and within firms and between firms and local institutions thus remain far more distinct in this independent firm based system.

By the mid to late 1980s, the so called "Massachusetts Miracle" began to falter, and many computer producers moved away from Route 128 to Silicon Valley. At the same time as Route 128 was going into decline, Silicon Valley was beginning to surge ahead. This surge was fuelled by the fact that high technology companies realised that Silicon Valley had a distinct regional advantage over Route 128. Saxenian (1994) discusses this regional advantage as having three major components, namely *local institutions and culture, industrial structure* and *corporate organisation.*

Local institutions include government and non-government institutions such as universities, colleges, business organisations and in Australia would also include State and Local Government bodies, as well as less formal organisations which all combine to maintain social interactions within a region. According to Saxenian, these government and non government organisations are shaped by the region's culture, including, for example, the region's labour market behaviour and risk taking attitudes. She believes that this on-going social interaction continually impacts on, and changes, a region's culture. Industrial structure refers to the social division of labour, that is, to the degree of vertical integration, as well as to the forward and backward linkages which exist between firms and their suppliers and customers. Finally, corporate organisation, according to Saxenian, includes the

degree of hierarchical or horizontal co-ordination, centralisation or decentralisation, and the allocation of responsibilities and specialisation of tasks within the firm.

If we are then to assume that Saxenian is right about the fact that it was Silicon Valley's regional advantage over Route 128 which led to its upsurge, it would mean that Adelaide's ability to develop a successful and sustainable high technology industry would be dependent on its ability to develop and maintain a regional advantage over other Australian capitals. Furthermore, it appears that Adelaide has many of the necessary elements suggested by Saxenian, which could provide Adelaide with just such a regional advantage, facilitating its emergence as a centre of high technology industrial development.

The objectives of the present study, as set out in Chapter 5, can be linked closely to Saxenian's ideas relating to regional advantage. The study has found that Adelaide's high technology establishments are not scattered haphazardly across the Metropolitan Area. Indeed, the majority of establishments may be found in one of two major clusters, the Central Region, around the City of Adelaide and the Northern Region, centered around Technology Park. Interestingly, the study has shown that it is not Technology Park which has the largest agglomeration of firms, but rather the City of Adelaide and its surrounding inner suburbs. The reasons for this spatial distribution were found to be linked to the unattractiveness of Technology Park, an issue which will be pursued later, as well as some very real advantages of a location close to the city.

In relation to the Central Region, Porter (1996) argues that the advantages of a location in the inner city fall into four groups, the first of which is *strategic location*. Porter notes that inner cities can offer a competitive edge to companies which benefit from being close to other firms and service providers. The findings of the study confirm this, and indeed being close to two universities, suppliers of

inputs, and having easy access to courier companies were prevailing reasons why so many firms located in or near the City of Adelaide. The second advantage of the inner city, according to Porter, is *local market demand*. He notes that the inner city market represents the most immediate opportunity for businesses based in the inner city. Indeed this point was discovered in the study, where high technology firms, in searching for suppliers of particular goods or services, would look firstly to those firms located nearby, as there would frequently be a need for face-to-face contact, especially if firms needed to have a product custom made. Porter's third advantage of the inner city is *integration with regional clusters*, its ability to capitalise on nearby regional clusters, such as Technology Park. This study however revealed that there does not seem to be a great amount of interaction between firms located in the inner city and those on Technology Park. Finally, argues Porter, the inner city also has an advantage in terms of *human resources*. In Adelaide this proved to be true, as the study revealed that the Central Region, because of its transport links and its central location, has access to a very specialised labour force, in effect from the entire metropolitan area. This is in contrast with the Northern Region, which has access only to the labour force residing in the northern and north-eastern suburbs, as it is unlikely that someone residing in Noarlunga would be prepared to travel to Technology Park everyday.

Despite popular belief that more peripheral regions are generally dominated by branch plants, the study has shown this not to apply to Adelaide, which has very few branch plants. The high technology electronics industry is mainly dominated by small flexible firms, many of which were created locally as a result of spin-offs from larger companies by individual entreprenuers. Furthermore, although a number of multi-establishment firms was identified, the majority of them

function as the Australian headquarters of the organisation and they operate branches in other Australian capitals.

The study indicated that two distinct *types* of products are manufactured by Adelaide's high technology firms. The first are products which are sold to final demand; the second group consists of intermediate products which are sold to other manufacturers. Some manufacturers produce only one type of product, whereas others produce both. While the product diversity varied enormously, printed circuit boards were the most commonly made articles.

The importance of a suitably skilled labour force to support high technology regional development has been emphasised repeatedly in the literature. The present study has shown that Adelaide can obtain most of its high-skilled employees locally. In addition, employers report that this labour is available more cheaply than in other states and is characterised by low rates of turnover.

The study also examined the types of people who establish high technology firms. Nearly three-quarters of all the founders of single-establishment firms were engineers, with training in either electronic, electrical or mechanical engineering. This finding though, was not unexpected. Interesting however, was the fact that the remaining founders had formal training in quite unrelated fields.

A number of factors was cited as having influenced individuals to establish a high technology business. Many firms were established to fill a particular market niche. The literature (Glasmeier, 1988; Malecki and Nijkamp, 1988; Markusen and Bloch, 1985) also cites the importance of spin-offs in the creation of high technology firms and indeed, several firms in Adelaide were created in this manner. The literature (Amin, 1989) also refers to high technology as a craft industry and once again the study identified firms which were established in, and still operate out of, the founder's shed, producing a very limited range of products.

The importance of venture capital to the start-up of many small high technology firms has also been discussed in the literature. In contrast to the United States, where venture capital is readily available, firms in Adelaide have had extreme difficulties in convincing banks or financiers to lend them money to establish a high technology business.

It would seem this is an area in which the State Government could make a significant contribution to help small high technology firms to "get off the ground". The establishment of a government agency which would examine the ideas put forward by potential entrepreneurs and organise financial assistance if the proposal looks feasible would not only see a far smaller rate of business failure, but would also encourage people who may have had a good idea, but did not have the financial means to put the idea into practice. Rahm and Luce (1992), describing Pennsylvania's economic development programmes, see their success as a consequence largely of state government support for higher education and in particular efforts to foster collaboration between universities and the private sector.

Adelaide has three universities within the Metropolitan Area. As mentioned previously, high technology firms have clustered into two main regions - namely the Central Region and the Northern Region, both of which contain tertiary institutions; firms in the Central Region are close to both the University of Adelaide and the University of South Australia, whilst the firms located in the Northern Region are clustered around The Levels Campus of the University of South Australia. Such close proximity allows the firms to interact with these institutions for the purposes of designing and developing new products and technologies. Indeed the findings of the study confirm this, with over a third of all firms undertaking research and development in conjunction with a tertiary institution.

Adelaide also has a long standing history of technological development. The Defence Science Technology Organisation has for half a century been actively involved in the development of weaponry for the Australian Defence Forces. Dating from the 1960s, Woomera in the state's north has been an Australian base for space research, while more recently, the location of the Submarine Corporation on the Port River has renewed confidence in the State as a high technology region.

Whilst the existence of such institutions has proved to be of great value to Adelaide's high technology firms, the study nonetheless revealed that many difficulties still exist with regards to backward linkages. A number of firms have described problems in obtaining particular inputs. These problems, ranging from extremely long lead times to the lack of available components in South Australia (and sometimes in Australia), and the difficulties associated with importing such components, all contribute to making the Adelaide Region less attractive for high technology development. Furthermore, there were several cases noted of difficulties in having equipment serviced. Whilst some of the problems are not related specifically to the Adelaide Region, others nonetheless are. These include situations where expertise to repair various equipment is not available locally and it is necessary to ship such equipment interstate for repairs, or alternatively to fly in experts from interstate to repair the equipment on site.

Such difficulties as those mentioned above pose a challenge to governments and policy makers. If Adelaide is to be regarded as the 'high tech' capital of Australia, then one would expect that a government department or agency could aggregate all of this demand for high technology back-up service and thereby justify the provision of such services in Adelaide. These additional services could be provided through the training of existing personnel, who already service the high

technology industries, so that they are able to service and repair a greater variety of equipment and thereby eliminate some of the above-mentioned problems.

On the other hand, forward linkages seem far better developed than backward linkages. The study found that most firms had a good relationship with their customers and that the vast majority of customers were satisfied with the products and services provided by high technology firms. Testimony to this is the fact that the most widely used form of advertising is 'word of mouth', whereby satisfied customers recommend a firm to others. Indeed, for many small high technology firms with limited budgets, this is their sole form of advertising.

The present study also found that, with only a few exceptions, all high technology firms relied to some degree on the local market in order to sell their products/services. But interstate markets are also very important and a number of firms indicated that in terms of volume of products sold, interstate markets were more important than the local market. Conversely, overseas markets were found to be of far lesser significance to high technology firms. Only about one-quarter of the firms surveyed sell a product overseas and even then these markets are only of secondary importance. The main factors contributing to this relatively poor overseas performance are the perception by overseas customers of Australia as a 'technological backwater' and the fact that a large proportion of the firms surveyed are very small and lack the financial means to penetrate overseas markets.

No major difficulties were found to exist in the area of forward linkages, although the study noted that a firm's lack of expertise or a customer's reluctance to pay the full cost of research and development were the two main difficulties which prevented new ideas coming to fruition as commercial products.

On the whole the study found that forward and backward linkages, both on a local and national level are somewhat immature, with the Adelaide Region still

having to be reliant on other high technology regions. While this is not a bad thing in itself, as it promotes dialogue between regions and hence may lead to further advances in high technology development, Adelaide seems to be too reliant on other regions for basic inputs, such as the access to components of a general nature, as well as access to services and service personnel. At present these detract from Adelaide's overall appeal to some high technology firms and may indeed be hampering Adelaide's ability to develop into a larger and more integrated high technology cluster. In other words, the Adelaide Region is not yet characterised by the "embeddedness" or networking that occurs in mature high technology regions.

Park (1996) has developed a model which portrays the different types of networks which can develop in different kinds of regional clusters. This model is based on a classification of linkages, backward (suppliers) and forward (customers), into local and non-local, and weak or extensive (strong). On this basis he sees the possibility of nine different kinds of high technology clusters (Figure 6). Park theorises about the ways in which these regions may or may not evolve and develop, with type 9 being the most mature (Figure 7). This region has strong backward and forward local linkages, that is, highly embedded firms, as well as strong inputs from outside the region and strong outputs to other regions.

Adelaide would fit into this model as a type 3 region, with strong non-local supplier linkages and strong local customer linkages, but with weaknesses in relation to local inputs and non-local outputs. In addition, Park suggests that the local suppliers in type 3 regions tend to be small, which is certainly true of Adelaide.

According to Park, the production systems of a type 3 region are a mix of flexible and mass production systems and as the region develops, local

Figure 6: NETWORK PATTERN OF SUPPLIERS AND CUSTOMERS

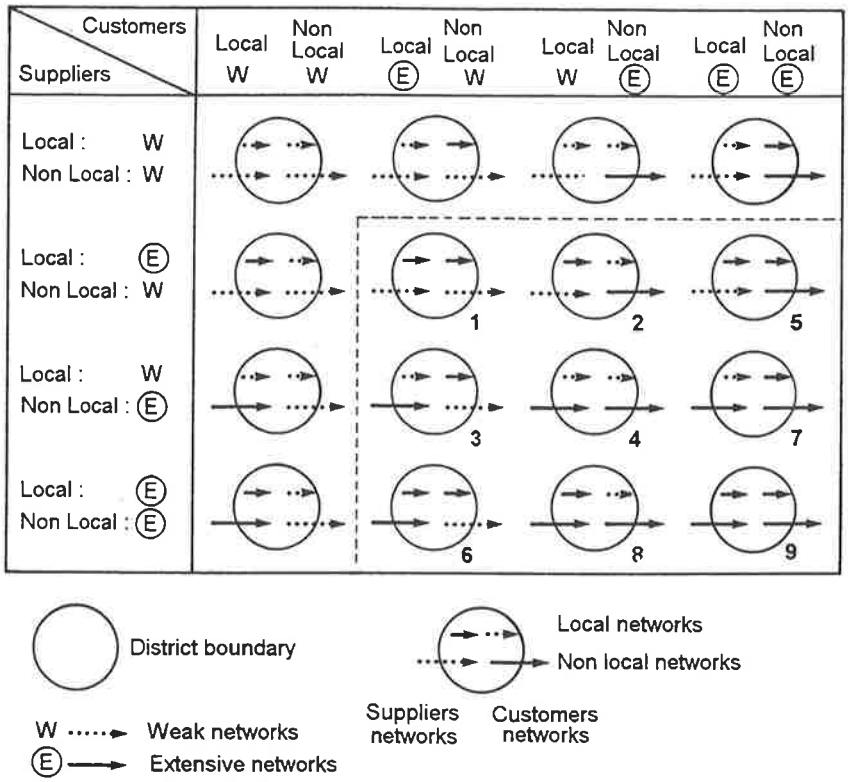
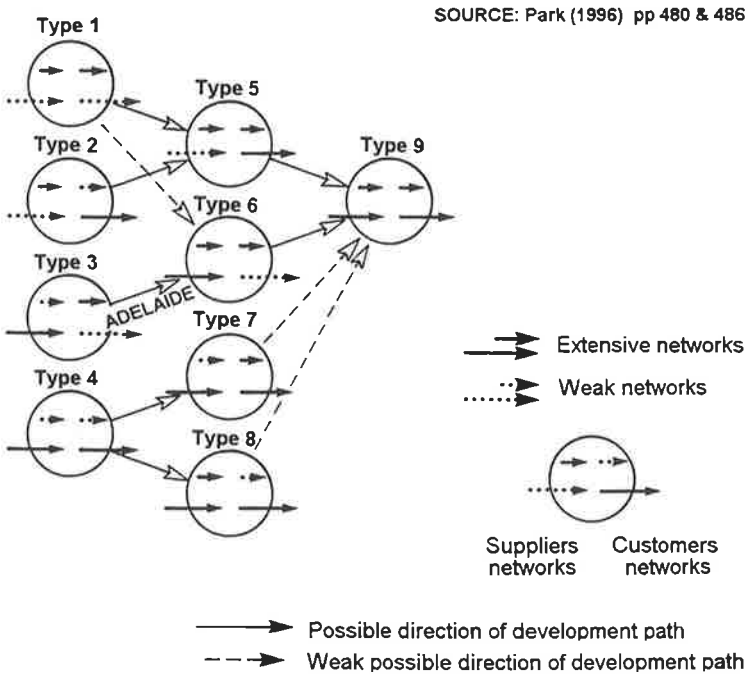



Figure 7: POSSIBLE DEVELOPMENT PATHS OF NEW INDUSTRIAL DISTRICTS



embeddedness or networking will become more important, hence according to Park's theory, Adelaide is heading towards becoming a type 6 region as local backward (supplier) linkages evolve (Figure 7). This study has pointed out repeatedly the fact that at present local linkages, especially between suppliers and high technology firms are immature and the fact that so many respondents have mentioned the need to improve local linkages.

It would seem therefore, that Adelaide has not yet reached a critical mass as a high technology district with large numbers of embedded firms with strong local backward and forward linkages. This does not mean that such a region is completely self sufficient. On the contrary, the most mature high technology regions (Park's type 9), such a Silicon Valley, have strong links with both customers and suppliers located outside the region.

Adelaide's transition from a type 3 to a type 6 region is by no means assured. In order for development to continue, for thresholds to be crossed, considerable "nurturing" will be required. In particular, at the present stage of development, encouragement of local suppliers of inputs, both materials and services, is required, as well as assistance in the development of non-local markets. The Government is already active in both these areas and this activity needs to be sustained. For example, in relation to the local input problem, the development of the Multi-Function Polis should attract high technology firms and high technology labour into the region. The MFP Chief Executive has stated that development of the MFP over the next few years will "have a far reaching effect in SA's technology industry builders, such as Technology Park and Adelaide's three universities... would drive technology based jobs growth at Technology Park during the next 10 to 12 years by more than 300 per cent." (Hopkins, 1997 p. 23).

Interestingly, he makes no reference to the fact that most high technology electronics firms are not located at Technology Park!

On a macro level, the study found Adelaide to be a most attractive city for the location of high technology firms. Compared with both Melbourne and Sydney, land and buildings are far cheaper in Adelaide. Likewise, labour costs are lower and the quality of labour is *on par* with the eastern states. Another factor which gives Adelaide a regional advantage over other state capitals is the quality of life. This last factor proved to be an almost universal reason for why firms were either established in Adelaide or why they decided to move to Adelaide. This finding supports the observations of Morfessis (1994), who argues extensively about the quality of life as a crucial ingredient in the economic development process. Morfessis believes that for an area to experience economic growth, it must provide a high level of public safety and welfare, environmental quality and a reasonable cost of living. In Chapter 4 it was revealed that the functions and facilities which are provided by a major metropolitan area are a very important locational factor for the high technology labour force. But at the same time other non-urban amenities are also very important. Adelaide provides an ideal location. It is large enough to provide good quality high order functions - restaurants, galleries, opera, sporting events, education, health care and good quality reasonably priced housing. At the same time it is surrounded by natural beauty within a short travelling time of the city, ranging from the hills to coastal beaches, from market gardens to vineyards and wine making regions. Furthermore, the area must have a compelling image and a unique set of attractions. The study revealed that this is indeed very important for the high technology sector and that for many firms this was a major factor in keeping them in South Australia, despite a number of respondents noting that their main markets were interstate.

The establishment of Technology Park proved to be important in attracting high technology businesses to the region. While only a small proportion of the firms studied are actually located at the Park, the vast majority of business located off the Park believe that the Park is important in that it gives Adelaide a high technology image, which in turn, results in increased business for many companies. Many of the firms located at the Park, whilst they could not describe many tangible advantages of their location, nonetheless believe the Technology Park address is very important for their image, especially when dealing with overseas customers.

Saxenian (1994) makes the point that not all economic activity clusters within a single regional economy, and that firms usually serve global markets and therefore collaborate with distant customers, suppliers and competitors. She also notes that the creation of regional clusters and the globalisation of production go hand in hand, as firms reinforce the dynamism of their own localities by linking them to similar regional clusters elsewhere.

The points mentioned above by Saxenian require a region to have the means to be well linked with other high technology regions. Apart from telecommunications, more physical communication is also required not only in the transporting of goods in various directions, but also in the movement of engineers and business people for face to face contact with other engineers and high technology firms owners for the exchange of information and ideas. The study, nonetheless showed that Adelaide is at a disadvantage in this area, due to the lack of flights out of Adelaide airport. Many overseas destinations cannot be reached by direct flights from Adelaide, and even Canberra is serviced by only a few direct flights each week. In most cases, the study noted that business people need to travel via Melbourne, and this entails lengthy delays.

Adelaide's physical distance from the main high technology markets of Sydney and Melbourne is also a problem. While the city itself cannot move closer to these markets, what is needed are better links between Adelaide and the eastern seaboard, and this is an area where the State Government and policy makers could make a number of changes. A step in the right direction has been the decision to proceed with the building of the new runway at Adelaide airport, which should give Adelaide greater export potential.

A number of additional obstacles was also noted which could hamper the development of a high technology industrial district in Adelaide, in particular the lack of capital, so essential to the expansion of any business. Indeed, 33 per cent of companies stated that this was the only factor which prevented or limited expansion. This situation has been identified also by Oakey (1985), who found that high technology establishments, and especially the small ones, face a constant conflict between the need for inevitably expensive research and development and a shortage of investment capital. He concluded that these establishments tend to adopt an introverted approach to innovation and only move forward in increments when money becomes available.

Companies also felt that the increasing competition from overseas establishments was reducing their access to an already limited local market, and this was making it more difficult for locally based high technology establishments to expand their operations and compete with large overseas conglomerates. The remaining establishments said that the potential growth was limited by government impediments, such as taxes, and the difficulty of attracting new customers.

On a micro level, the majority of high technology firms were satisfied with their locational decision, indicating that these firms have not chosen their present

location in an *ad hoc* manner. Firms tended to choose a location which was close to suppliers, customers and other facilities such as banks or restaurants. For several smaller firms, the study noted that a location close to the owner's/manager's home was also important. Several firms also noted that being close to Adelaide airport was advantageous. Modern premises at a reasonable cost also featured highly in a firm's location decision.

The greatest single disadvantage noted by high technology firms about their current location was that the current premises were fairly old and lacked room for expansion. Furthermore, a number of firms located at Technology Park stated that the excessively high costs of rent and the Park's remoteness from the CBD, airport, customers and suppliers outweighed any advantages and indeed some of these businesses were about to move to a location closer to the city centre.

The study found only a handful of firms which do not produce anything themselves, but which supply high technology establishments with electronic componentry and other related inputs. No suppliers were found to exist in the Northern Region. The links between component suppliers and high technology firms were found to be rather weak. On the one hand, stocks held by local suppliers are demand driven, hence theoretically, if the number of firms in Adelaide using local suppliers increased, then the number and diversity of stock offered by these suppliers would also increase. Too many high technology firms however 'mail order' components from interstate and overseas, stating that the necessary components are not available locally. Ironically, the local suppliers are forced to sell much of their stock interstate, due to a lack of local demand. Thus, as the situation stands at present, local suppliers lose a large amount of potential business to interstate and overseas suppliers, whilst high technology establishments, instead of trading with a local company, go through the problems

and expense associated with 'mail ordering' components. If a mutual agreement could be reached between the two, then both parties, and the state economy, would benefit.

Looking toward the future, the study attempted to discover in what ways respondents believed that their businesses may change, if at all. One quarter replied that they have not thought about any form of expansion or change in the business in the foreseeable future, This was explained either through a lack of capital, or the desire simply to remain the same without altering the line of work. Thirty four per cent of companies said that in the future they will be expanding in size and will be employing additional staff. This may be brought about as a result of additional manufacturing and/or design work or through the expansion into national and overseas markets. Thirty per cent will diversify into related fields of work, although they will generally keep their original line of business. This diversification includes the establishment of a new product line, the movement into providing additional services to potential customers such as consultancy and design services, or, in a few cases, changing the entire course of the business. Six per cent of the establishments surveyed feel that in the future they will both expand and diversify. Forty three per cent stated that they could not identify any impediments to expansion.

And so to the original question. High technology development requires a combination of very specialised resources such as highly trained scientific and technical personnel in facilities for carrying out state-of-the-art research, entrepreneurs with technical expertise as well as business acumen. It is extremely doubtful that any state could assemble all these resources in one area, unless some are already present. If some resources are present, state initiatives may be

able to reduce or eliminate obstacles to the development of those that are lacking and thus greatly influence the location of high technology firms.

Thus it would seem that Adelaide's attraction as a high technology district does not depend on having minimal government regulation - it depends on having appropriate regulation and appropriate government involvement. For example the slavish ideological pursuit of removing all government 'red tape' and allowing greater "freedom" for developers, could well destroy the features of Adelaide which make it so attractive in the first place. Any state can provide the 'business environment', but not all can provide the quality of life which Adelaide can, thus giving free reign to developers and reducing the need for Environmental Impact Statements for example, would be disastrous.

Work has finally begun on the long awaited Multi-Function Polis. The project promises to attract many high technology firms and highly experienced personnel. If the project proves to be as successful as the Government hopes it will be, then coupled with the attributes already present, Adelaide is certainly poised to become the high technology industrial district of Australia.

# 13. APPENDICIES

## *APPENDIX A: THE QUESTIONNAIRE FOR ALL HIGH TECHNOLOGY ESTABLISHMENTS*

### *Origins of the Business*

**For Branch Plants:**

1. What is the name of your parent company?
2. Where are the headquarters of the parent company?
3. What other branches does the parent company operate in South Australia, or indeed Australia?
4. What role does this particular branch plant play in the larger corporate structure of the firm, eg. do you have a similar function to other branch plants or do you do something unique?

**For Individual/Independent Firms:**

5. When was the business established and how did it come into existence?
6. Who was the founder of the business (education, place of birth/residence, previous experience in jobs or businesses)?
7. Why did you decide to set up in business, and why this particular kind of business?
8. What types of inputs did you require to establish this business, and were these available locally?

## *The Business in relation to its Economic Environment*

**Labour:**

9. What is the size of your total workforce and how many employees are involved directly in electronics?
10. What are their skills and/or qualifications?
11. In what type of work are your employees engaged in?
12. Were employees with the skills that you require readily available in Adelaide, or if not, where were they recruited from?
13. What is the frequency of your labour turnover?

**Materials or Components:**

14. What types of materials or components, if any, do you purchase from other firms?
15. Who are the suppliers of these inputs - are they local, interstate or overseas?
16. Do you, or have you in the past experienced any problems in obtaining your inputs and what was the nature of these problems?
17. What kinds of interactions do you have with your suppliers, ie. do you have close contacts with your suppliers, are you able to purchase your inputs "ready made" or do they have to be "tailor made" to your requirements?

**Plant and Equipment:**

18. Do you have any difficulties in having your equipment maintained and serviced - is this done by local firms or do technicians have to be brought in from elsewhere?

**Other Inputs:**

19. Does this firm buy in any other services, eg. business services, computer programming, keying-in of data, software, accounting and legal services, advertising etc.

    *If so,*

20. Are all of these services available locally or do you have to look interstate, and are there any difficulties in obtaining these services?

21. Has your firm had any contact with any of the universities or colleges in Adelaide, for what purposes and did the exercise prove fruitful?

**Marketing of the Products:**

22. Do you sell any of your products to customers through wholesales and retailers, ie. to final demand? If so, what percentage is sold locally, interstate and overseas?

23. Are any of your products sold to other firms? If so:

    - to what kinds of firms?
    - where are they located?
    - what percentage of sales is directed to each customer and are you dependent on any particular firms for the majority of your sales?
    - are these firms in Adelaide, interstate or overseas?

24. How do you discover or establish markets for your products, eg. do potential customers come to you, if so, how do they learn about you, or do you seek out potential customers, and if so, how?

25. Do you sell a general product(s) to customers, or do you provide a consultancy service, whereby potential customers come to you for a "tailor made" product to suit their particular needs?

26. How often do you adapt or change your product, what sort of changes do you make, and why? (is it because you perceive market opportunities for new products or do customers approach you with particular needs?)
27. Do customers ever approach you for a product which you are unable or unwilling to supply? If so, why not?

### *Growth Prospects*

28. Do you wish to expand your business in the future, and if so, what form will that expansion take, ie. will it simply mean a bigger operation or will you diversify into other fields?
29. Do you perceive there to be any obstacles to the future growth of this firm?

### *Location Analysis*

30. Have you considered establishing your firm in another capital?
31. What benefits or advantages does Adelaide offer as a location for your business?
32. Are there any obstacles or disadvantages which Adelaide has as a location for your business?
33. To what extent does Adelaide compensate for any business disadvantages by being an attractive place for you and your workforce to live?
34. Do you think your business would be more profitable, or more easily managed somewhere else in Australia and why?
35. Are there any ways in which the State Government could make Adelaide a better place for you to run your business?

## *Location Factors*

**For Firms outside Science/Technology Park:**

36. What do you perceive as being the advantages and disadvantages of this particular site (in terms of its size, the building, labour supply, local government controls, costs etc.)?
37. Have you ever considered moving to a different location in Adelaide? If so, what has stopped you?
38. Have you considered locating at either Science or Technology Park?
39. If yes, what did you perceive as being the advantages of locating at one of the Parks?
40. If not, what did you find unattractive about either or both of the Parks?
41. Did you however, perceive the location of Science or Technology Park as being beneficial to the future development of your firm?

**For firms located at Science or Technology Park:**

42. Have you always been located at the Park? If not, where was your original site?
43. What do you believe are the advantages and disadvantages of locating on the Park compared to a site elsewhere in Adelaide?
44. Do you take advantage of other firms at the Park when you need to find suppliers of specific goods or services, ie. do you take advantage of the agglomeration economies offered by a Park environment?

## *APPENDIX B: THE QUESTIONNAIRE FOR SUPPLIERS TO HIGH TECHNOLOGY COMPANIES*

### *Origins of the Business*

**For Branch Plants:**

1. What is the name of your parent company?
2. Where are the headquarters of the parent company?
3. What other branches does the parent company operate in South Australia, or indeed Australia?
4. What role does this particular branch plant play in the larger corporate structure of the firm, eg. do you have a similar function to other branch plants or do you do something unique?

**For Individual/Independent Firms:**

5. When was the business established and how did it come into existence?
6. Who was the founder of the business (education, place of birth/residence, previous experience in jobs or businesses)?
7. Why did you decide to set up in business, and why this particular kind of business?
8. What types of inputs did you require to establish this business, and were these available locally?

### *The Business in Relation to its Economic Environment*

**Labour:**

9. What is the size of your total workforce and how many employees are involved directly in electronics?

10. What are their skills and/or qualifications?
11. In what type of work are your employees engaged in?
12. Were employees with the skills that you require readily available in Adelaide, or if not, where were they recruited from?
13. What is the frequency of your labour turnover?

**Import and Marketing of Components:**

14. What types of materials or components do you import and distribute?
    Where do the components originate from?
    (specify some countries/regions/firms)
15. Do you import your components directly into Adelaide from overseas, or are they purchased through a wholesaler or distributor interstate?
16. How are decisions made as to which components will be purchased? Are these decisions market driven?
17. Are you the sole South Australian agent for these components?
18. Do you sell components directly to customers, or do you sell them through wholesalers?
19. Are you dependent on any one customer or on a core of regular customers?
20. What types of companies purchase components from you?
21. Do you adapt or customerise any components before you sell them to a customer?
22. Do you provide advice/expertise to customers to assist them in choosing the right components?
23. Do you sometimes find it difficult to supply a customer with the components that they require?

24. How do you discover or establish markets for the components which distribute, *eg.* do potential customers come to you, if so, how do they learn about you, or do you seek out potential customers, and if so, how?

### *Growth Prospects*

26. Do you wish to expand your business in the future, and if so, what form will that expansion take, ie. will it simply mean a bigger operation or will you diversify into other fields?
27. Do you perceive there to be any obstacles to the future growth of this firm?

### *Location Analysis*

28. Have you considered establishing your firm in another capital?
29. What benefits or advantages does Adelaide offer as a location for your business?
30. Are there any obstacles or disadvantages which Adelaide has as a location for your business?
31. To what extent does Adelaide compensate for any business disadvantages by being an attractive place for you and your workforce to live?
32. Do you think your business would be more profitable, or more easily managed somewhere else in Australia and why?
33. Are there any ways in which the State Government could make Adelaide a better place for you to run your business?

### *Location Factors*

34. What do you perceive as being the advantages and disadvantages of this particular site (in terms of its size, the building, labour supply, local government controls, costs etc.)?
35. Have you ever considered moving to a different location in Adelaide? If so, what has stopped you?
36. Have you considered locating at either Science or Technology Park?
37. If yes, what do you perceive are the advantages of locating at one of the Parks?
38. If not, what do you find unattractive about either or both of the Parks?
39. Did you however, perceive the location of Science or Technology Park as being beneficial to the future development of your firm?

## *APPENDIX C: PRODUCTS MADE BY HIGH TECHNOLOGY FIRMS IN ADELAIDE*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION | SALES TO : | |
|---|---|---|---|---|
| | | | Final Demand | Other M'facturers |
| | | ***MULTI-ESTABLISHMENT FIRMS*** | | |
| 1. | Newton | Design and manufacture of communication equipment | ✓ | ✓ |
| 2. | North Plympton | Design and manufacture of irrigation equipment | ✓ | |
| 3. | Technology Park | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post | ✓ | ✓ |
| 4. | Hendon | Design and manufacture of electronic components and engine management systems | | ✓ |
| 5. | Technology Park | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) | ✓ | |
| 6. | Holden Hill | Manufacture of remote control door opening controllers | ✓ | |
| 7. | Technology Park | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | ✓ | ✓ |
| 8. | Unley | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | | ✓ |
| 9. | Adelaide Airport | Design and manufacture of electronic speed controllers for evaporative air conditioners | | ✓ |
| 10. | Thebarton | Design and manufacture of precision weighing instruments, load cells & digital controllers | ✓ | ✓ |
| 11. | Kilburn | Development of load cells, crane weighing systems and their manufacture | ✓ | ✓ |

*Appendix C: Products Made by High Technology Firms in Adelaide (continued...)*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION | SALES TO : | |
|---|---|---|---|---|
| | | | Final Demand | Other M'facturers |
| 12. | Forestville | Development of monitoring equipment for the mining industry and software development needed to run the given equipment | ✓ | |
| 13. | Adelaide | Design and manufacture of time management clocks and all associated software | ✓ | |
| 14. | Technology Park | Development of radio frequency technology; systems engineering | | ✓ |
| 15. | Kent Town | Design and development of computer controlled air conditioning systems for hospitals etc. | ✓ | ✓ |
| 16. | Dulwich | Design and assembly of voice and data communication systems | ✓ | |
| 17. | Parkside | Manufacture and installation of security systems | ✓ | |
| | | ***SINGLE-ESTABLISHMENT FIRMS*** | | |
| 18. | Thebarton | Design and manufacture of process control instrumentation | | ✓ |
| 19. | Eastwood | Design and manufacture of process control instrumentation | ✓ | |
| 20. | Keswick | Manufacture of Printed Circuit Boards | | ✓ |
| 21. | Edwardstown | Manufacture of Printed Circuit Boards | ✓ | |
| 22. | Newton | Manufacture of Printed Circuit Boards | | ✓ |
| 23. | Salisbury South | Manufacture of Printed Circuit Boards | | ✓ |
| 24. | Adelaide | Manufacture of Printed Circuit Boards | ✓ | ✓ |
| 25. | Technology Park | Manufacture of Printed Circuit Boards | | ✓ |
| 26. | Unley | Manufacture of Printed Circuit Boards | ✓ | |

*Appendix C: Products Made by High Technology Firms in Adelaide (continued...)*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION | SALES TO : | |
|---|---|---|---|---|
| | | | Final Demand | Other M'facturers |
| 27. | Bowden | Production of safety switches and safety circuits for hospitals | ✓ | ✓ |
| 28. | Regency Park | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities | ✓ | |
| 29. | Technology Park | Software design; building and testing of various prototypes for the defence industry | ✓ | |
| 30. | Unley | Design and manufacture of laser based products | ✓ | ✓ |
| 31. | Adelaide | Design and manufacture of laser based products | ✓ | |
| 32. | Thebarton | Development and manufacture of safety systems for cranes | ✓ | ✓ |
| 33. | Edwardstown | Manufacture of computer memories, computer hardware and monitors | ✓ | |
| 34. | Edwardstown | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ |
| 35. | Technology Park | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ |
| 36. | Technology Park | Manufacture of computer memories, computer hardware and monitors | | ✓ |
| 37. | Technology Park | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ |
| 38. | North Adelaide | Consultancy work for the defence industry | ✓ | |
| 39. | Norwood | Development of communication equipment and the manufacturing of prototypes | ✓ | |
| 40. | Hindmarsh | Design of specialised controllers and all associated software | | ✓ |
| 41. | Adelaide | Design of radio frequency systems tags, eg for the Sydney Road Authority | ✓ | ✓ |
| 42. | Reynella | Manufacture of electronic components for car manufacturers and also for the telecommunications industry | ✓ | ✓ |

*Appendix C: Products Made by High Technology Firms in Adelaide (continued...)*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION | SALES TO : | |
|---|---|---|---|---|
| | | | Final Demand | Other M'facturers |
| 43. | Rose Park | Design, development and manufacture of electronic metal detectors, ranging from amateur to military applications | ✓ | ✓ |
| 44. | Kilkenny | Design, development and installation of electronic engine management systems | | ✓ |
| 45. | Hindmarsh | Production of master compact disks and making of copies | ✓ | |
| 46. | Prospect | Design and manufacture of microwave communications systems | | ✓ |
| 47. | Stepney | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications | ✓ | |
| 48. | Kent Town | Manufacture of portable moisture sensors for the agriculture industry | ✓ | |
| 49. | Norwood | Development of monitoring equipment for rainfall, water quality etc. | ✓ | |
| 50. | Magill | Development of monitoring equipment for rainfall, water quality etc. | ✓ | |
| 51. | Technology Park | Design of silicon chips and integrated circuits | ✓ | |
| 52. | Adelaide | Design of custom electronic systems | ✓ | |
| 53. | Salisbury South | Design of electronic products for customers on a one-off basis | ✓ | ✓ |
| 54. | Sheidow Park | Sub-contracted electronics assembly and in-house design of various items | ✓ | ✓ |
| 55. | Woodville North | Design of data logging equipment, mainly for government utilities | ✓ | |
| 56. | Henley Beach | Design of data logging equipment, mainly for government utilities | ✓ | ✓ |
| 57. | Technology Park | Design of data logging equipment, mainly for government utilities | | ✓ |

*Appendix C: Products Made by High Technology Firms in Adelaide (continued...)*

| FIRM NO. | LOCATION OF FIRM | SERVICE AND/OR PRODUCT DESCRIPTION | SALES TO : | |
|---|---|---|---|---|
| | | | Final Demand | Other M'facturers |
| 58. | Norwood | Design and manufacture of telecommunications equipment to fill niches not covered by Telecom, eg specialised intercom and pager systems | ✓ | ✓ |
| 59. | Edwardstown | Alterations of security equipment to suit specific applications | | ✓ |
| 60. | Technology Park | Design work for the Department of Defence; in-house development of defence oriented equipment | | ✓ |
| 61. | Joslin | Redesign of ageing electronic equipment to reduce costs and increase functions; data communications in a factory environment | ✓ | |

Source: Data from Questionnaire

## APPENDIX D: MOTIVATIONS OF THE FOUNDERS OF SINGLE-ESTABLISHMENT FIRMS

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | MOTIVATIONS OF FIRM FOUNDERS FOR ESTABLISHING BUSINESS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Demand Factors* | | *Supply Factors* | | | | |
| | | *To serve a particular industry* | *To fill a particular market niche* | *The desire to be "one's own boss"* | *Friends formed a partnership - wanted to run their own firm* | *Established by S.A. Govt. to commer-cialise a prod-uct* | *To develop an idea which was formed during previ-ous employ-ment* | *Business developed from a hobby* |
| 18. | Design and manufacture of process control instrumentation | ✓ | | | | | | |
| 19. | Design and manufacture of process control instrumentation | | ✓ | ✓ | | | | |
| 20. | Manufacture of Printed Circuit Boards | | | | ✓ | | | |
| 23. | Manufacture of Printed Circuit Boards | | | ✓ | ✓ | | | |
| 24. | Manufacture of Printed Circuit Boards | | ✓ | | | | | |
| 25. | Manufacture of Printed Circuit Boards | | ✓ | ✓ | | | | |
| 26. | Manufacture of Printed Circuit Boards | | ✓ | | | | | |
| 27. | Production of safety switches and safety circuits for hospitals | | ✓ | | | | | |
| 28. | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities | ✓ | ✓ | | | | | |
| 29. | Software design; building and testing of various prototypes for the defence industry | | | | | ✓ | | |
| 30. | Design and manufacture of laser based products | | ✓ | ✓ | | | | |
| 31. | Design and manufacture of laser based products | | | | | | ✓ | |
| 32. | Development and manufacture of safety systems for cranes | ✓ | ✓ | | | | | |
| 33. | Manufacture of computer memories, computer hardware and monitors | | ✓ | ✓ | | | | |
| 34. | Manufacture of computer memories, computer hardware and monitors | | ✓ | ✓ | | | | |
| 35. | Manufacture of computer memories, computer hardware and monitors | | | | | | | ✓ |
| 36. | Manufacture of computer memories, computer hardware and monitors | | | | | | | ✓ |
| 37. | Manufacture of computer memories, computer hardware and monitors | | ✓ | | | | | |

*Appendix D: Motivations of the Founders of Single-establishment Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | MOTIVATIONS OF FIRM FOUNDERS FOR ESTABLISHING BUSINESS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Demand Factors* | | *Supply Factors* | | | | |
| | | *To serve a particular industry* | *To fill a particular market niche* | *The desire to be "one's own boss"* | *Friends formed a partnership - wanted to run their own firm* | *Established by S.A. Govt. to commer-cialise a prod-uct* | *To develop an idea which was formed during previ-ous employ-ment* | *Business developed from a hobby* |
| 38. | Consultancy work for the defence industry | | | ✓ | | | ✓ | |
| 39. | Development of communication equipment and the manufacturing of proto-types | | ✓ | ✓ | | | | |
| 40. | Design of specialised controllers and all associated software | | | | ✓ | | | |
| 41. | Design of radio frequency systems tags, eg for the Sydney Road Authority | | | | ✓ | | ✓ | |
| 42. | Manufacture of electronic components for car manufacturers and also for the telecommunications industry | | ✓ | ✓ | | | | |
| 43. | Design, development and manufacture of electronic metal detectors, ranging from amateur to military applications | ✓ | | | | | | |
| 44. | Design, development and installation of electronic engine management systems | | | | | ✓ | | |
| 45. | Production of master compact disks and making of copies | | ✓ | | | | | |
| 46. | Design and manufacture of microwave communications systems | ✓ | ✓ | | | | | |
| 47. | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications | | | | | | | ✓ |
| 48. | Manufacture of portable moisture sensors for the agriculture industry | ✓ | ✓ | | | | ✓ | |
| 49. | Development of monitoring equipment for rainfall, water quality etc. | | | | ✓ | | | ✓ |
| 50. | Development of monitoring equipment for rainfall, water quality etc. | | | | | | ✓ | |
| 51. | Design of silicon chips and integrated circuits | | ✓ | | | | | |
| 52. | Design of custom electronic systems | | | ✓ | | | ✓ | |
| 53. | Design of electronic products for customers on a one-off basis | | ✓ | ✓ | | | | |
| 54. | Sub-contracted electronics assembly and in-house design of various items | | | ✓ | | | | ✓ |
| 55. | Design of data logging equipment, mainly for government utilities | | | ✓ | | | ✓ | |

*Appendix D: Motivations of the Founders of Single-establishment Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | MOTIVATIONS OF FIRM FOUNDERS FOR ESTABLISHING BUSINESS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Demand Factors* | | *Supply Factors* | | | | |
| | | *To serve a particular industry* | *To fill a particular market niche* | *The desire to be "one's own boss"* | *Friends formed a partnership - wanted to run their own firm* | *Established by S.A. Govt. to commer-cialise a prod-uct* | *To develop an idea which was formed during previ-ous employ-ment* | *Business developed from a hobby* |
| 56. | Design of data logging equipment, mainly for government utilities | | | ✓ | | | ✓ | |
| 57. | Design of data logging equipment, mainly for government utilities | | | ✓ | | | ✓ | |
| 58. | Design and manufacture of telecommunications equipment to fill niches not covered by Telecom, eg specialised intercom and pager systems | | ✓ | | | | | |
| 59. | Alterations of security equipment to suit specific applications | ✓ | | | | | | |
| 60. | Design work for the Department of Defence; in-house development of de-fence oriented equipment | ✓ | ✓ | ✓ | | | | |
| 61. | Redesign of ageing electronic equipment to reduce costs and increase func-tions; data communications in a factory environment | | | ✓ | | | ✓ | ✓ |

Source: Data from Questionnaire

## *APPENDIX E: ADVANTAGES OF ADELAIDE AS A LOCATION FOR HIGH TECHNOLOGY FIRMS*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF LOCATING IN ADELAIDE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Founders reside in Adelaide - no desire to move* | *Quality of life* | *Strong local defence network* | *Availabi-lity of highly skilled labour* | *Cheaper to operate business in Adelaide* | *Access to services is cheaper than interstate* | *Labour costs lower than interstate* |
| | ***MULTI-ESTABLISHMENT FIRMS*** | | | | | | | |
| 1. | Design and manufacture of communication equipment | ✓ | ✓ | | | | | |
| 2. | Design and manufacture of irrigation equipment | | ✓ | | | ✓ | | |
| 3. | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post | | ✓ | ✓ | | | ✓ | |
| 4. | Design and manufacture of electronic components and engine management systems | ✓ | | | ✓ | | | ✓ |
| 5. | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) | | ✓ | | | | ✓ | |
| 6. | Manufacture of remote control door opening controllers | | ✓ | | | | ✓ | ✓ |
| 7. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | | ✓ | ✓ | | | | |
| 8. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | ✓ | ✓ | | | ✓ | ✓ | |
| 9. | Design and manufacture of electronic speed controllers for evaporative air conditioners | ✓ | ✓ | | ✓ | | | |
| 10. | Design and manufacture of precision weighing instruments, load cells & digital controllers | | ✓ | | | | ✓ | ✓ |

*Appendix E: Advantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF LOCATING IN ADELAIDE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Founders reside in Adelaide - no desire to move* | *Quality of life* | *Strong local defence network* | *Availability of highly skilled labour* | *Cheaper to operate business in Adelaide* | *Access to services is cheaper than interstate* | *Labour costs lower than interstate* |
| 11. | Development of load cells, crane weighing systems and their manufacture | ✓ | ✓ | | ✓ | | | ✓ |
| 12. | Development of monitoring equipment for the mining industry and software development needed to run the given equipment | ✓ | ✓ | | | | | |
| 13. | Design and manufacture of time management clocks and all associated software | | ✓ | | ✓ | ✓ | | ✓ |
| 14. | Development of radio frequency technology; systems engineering | | | ✓ | | | | |
| 15. | Design and development of computer controlled air conditioning systems for hospitals etc. | | ✓ | | | | | |
| 16. | Design and assembly of voice and data communication systems | | ✓ | | | | ✓ | |
| 17. | Manufacture and installation of security systems | | | | | | ✓ | |
| | ***SINGLE-ESTABLISHMENT FIRMS*** | | | | | | | |
| 18. | Design and manufacture of process control instrumentation | | | | ✓ | | | ✓ |
| 19. | Design and manufacture of process control instrumentation | | ✓ | | | | | |
| 20. | Manufacture of Printed Circuit Boards | ✓ | ✓ | | | | | |
| 21. | Manufacture of Printed Circuit Boards | | ✓ | | ✓ | ✓ | ✓ | |
| 22. | Manufacture of Printed Circuit Boards | *no advantages noted* | | | | | | |
| 23. | Manufacture of Printed Circuit Boards | | ✓ | | ✓ | ✓ | | ✓ |
| 24. | Manufacture of Printed Circuit Boards | | ✓ | | | ✓ | | |
| 25. | Manufacture of Printed Circuit Boards | | ✓ | | | ✓ | ✓ | |

*Appendix E: Advantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF LOCATING IN ADELAIDE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Founders reside in Adelaide - no desire to move* | *Quality of life* | *Strong local defence network* | *Availability of highly skilled labour* | *Cheaper to operate business in Adelaide* | *Access to services is cheaper than interstate* | *Labour costs lower than interstate* |
| 26. | Manufacture of Printed Circuit Boards | *no advantages noted* | | | | | | |
| 27. | Production of safety switches and safety circuits for hospitals | | | | | | ✓ | |
| 28. | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities | *no advantages noted* | | | | | | |
| 29. | Software design; building and testing of various prototypes for the defence industry | | | ✓ | | | ✓ | |
| 30. | Design and manufacture of laser based products | | ✓ | | | ✓ | ✓ | ✓ |
| 31. | Design and manufacture of laser based products | ✓ | | | | ✓ | | |
| 32. | Development and manufacture of safety systems for cranes | | | | | ✓ | ✓ | |
| 33. | Manufacture of computer memories, computer hardware and monitors | *no advantages noted* | | | | | | |
| 34. | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ | | | ✓ | | |
| 35. | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ | | | ✓ | ✓ | |
| 36. | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ | | | | | |
| 37. | Manufacture of computer memories, computer hardware and monitors | | ✓ | | | | | |
| 38. | Consultancy work for the defence industry | | ✓ | | | ✓ | | |
| 39. | Development of communication equipment and the manufacturing of prototypes | | ✓ | | | | | |

*Appendix E: Advantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF LOCATING IN ADELAIDE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Founders reside in Adelaide - no desire to move* | *Quality of life* | *Strong local defence network* | *Availabi-lity of highly skilled labour* | *Cheaper to operate business in Adelaide* | *Access to services is cheaper than interstate* | *Labour costs lower than interstate* |
| 40. | Design of specialised controllers and all associated software | | | ✓ | ✓ | ✓ | ✓ | |
| 41. | Design of radio frequency systems tags, eg for the Sydney Road Authority | ✓ | ✓ | | | | | |
| 42. | Manufacture of electronic components for car manufacturers and also for the telecommunications industry | | ✓ | | | | | |
| 43. | Design, development and manufacture of electronic metal detectors, ranging from amateur to military applications | | | ✓ | | | | |
| 44. | Design, development and installation of electronic engine management systems | ✓ | ✓ | | | | | |
| 45. | Production of master compact disks and making of copies | ✓ | ✓ | | | | | |
| 46. | Design and manufacture of microwave communications systems | ✓ | ✓ | | | | | |
| 47. | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications | | ✓ | | | | | |
| 48. | Manufacture of portable moisture sensors for the agriculture industry | ✓ | ✓ | | | | | |
| 49. | Development of monitoring equipment for rainfall, water quality etc. | ✓ | ✓ | | ✓ | | | |
| 50. | Development of monitoring equipment for rainfall, water quality etc. | | ✓ | | | ✓ | | |
| 51. | Design of silicon chips and integrated circuits | ✓ | ✓ | | | | | |
| 52. | Design of custom electronic systems | | ✓ | | | | | |
| 53. | Design of electronic products for customers on a one-off basis | | ✓ | | | ✓ | | |
| 54. | Sub-contracted electronics assembly and in-house design of various items | | ✓ | | | | | |
| 55. | Design of data logging equipment, mainly for government utilities | | ✓ | | | ✓ | ✓ | |

*Appendix E: Advantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF LOCATING IN ADELAIDE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Founders reside in Adelaide - no desire to move* | *Quality of life* | *Strong local defence network* | *Availability of highly skilled labour* | *Cheaper to operate business in Adelaide* | *Access to services is cheaper than interstate* | *Labour costs lower than interstate* |
| 56. | Design of data logging equipment, mainly for government utilities | ✓ | ✓ | | | ✓ | ✓ | |
| 57. | Design of data logging equipment, mainly for government utilities | | ✓ | | | | | |
| 58. | Design and manufacture of telecommunications equipment to fill niches not covered by Telecom, eg specialised intercom and pager systems | *no advantages noted* | | | | | | |
| 59. | Alterations of security equipment to suit specific applications | | | | | | ✓ | |
| 60. | Design work for the Department of Defence; in-house development of defence oriented equipment | | ✓ | | | | | ✓ |
| 61. | Redesign of ageing electronic equipment to reduce costs and increase functions; data communications in a factory environment | ✓ | ✓ | | | ✓ | | |

Source: Data from Questionnaire

## *APPENDIX F: DISADVANTAGES OF ADELAIDE AS A LOCATION FOR HIGH TECHNOLOGY FIRMS*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF LOCATING IN ADELAIDE | | | | |
|---|---|---|---|---|---|---|
| | | *Lack of adequate airport services* | *Expensive to source components from interstate* | *Small local market* | *Lack of local expertise in the provision of service facilities* | *Remoteness from the major markets of Melb. & Syd.* |
| | ***MULTI-ESTABLISHMENT FIRMS*** | | | | | |
| 1. | Design and manufacture of communication equipment | ✓ | ✓ | | | |
| 2. | Design and manufacture of irrigation equipment | | | ✓ | ✓ | |
| 3. | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post | ✓ | | | | |
| 4. | Design and manufacture of electronic components and engine management systems | ✓ | | ✓ | | ✓ |
| 5. | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) | ✓ | | | | ✓ |
| 6. | Manufacture of remote control door opening controllers | | | | ✓ | |
| 7. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | ✓ | | | | ✓ |
| 8. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | ✓ | | | | |
| 9. | Design and manufacture of electronic speed controllers for evaporative air conditioners | ✓ | | | | |

*Appendix F: Disadvantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF LOCATING IN ADELAIDE | | | | |
|---|---|---|---|---|---|---|
| | | ***Lack of adequate airport services*** | ***Expensive to source components from interstate*** | ***Small local market*** | ***Lack of local expertise in the provision of service facilities*** | ***Remoteness from the major markets of Melb. & Syd.*** |
| 10. | Design and manufacture of precision weighing instruments, load cells & digital controllers | ✓ | | | | |
| 11. | Development of load cells, crane weighing systems and their manufacture | | | | | ✓ |
| 12. | Development of monitoring equipment for the mining industry and software development needed to run the given equipment | ✓ | | | | ✓ |
| 13. | Design and manufacture of time management clocks and all associated software | | | ✓ | | |
| 14. | Development of radio frequency technology; systems engineering | | | ✓ | | ✓ |
| 15. | Design and development of computer controlled air conditioning systems for hospitals etc. | | | ✓ | | ✓ |
| 16. | Design and assembly of voice and data communication systems | ✓ | ✓ | ✓ | | |
| 17. | Manufacture and installation of security systems | *no disadvantages noted* | | | | |
| | ***SINGLE-ESTABLISHMENT FIRMS*** | | | | | |
| 18. | Design and manufacture of process control instrumentation | *no disadvantages noted* | | | | |
| 19. | Design and manufacture of process control instrumentation | | ✓ | ✓ | | |
| 20. | Manufacture of Printed Circuit Boards | *no disadvantages noted* | | | | |
| 21. | Manufacture of Printed Circuit Boards | ✓ | | | | ✓ |
| 22. | Manufacture of Printed Circuit Boards | *no disadvantages noted* | | | | |

*Appendix F: Disadvantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF LOCATING IN ADELAIDE | | | | |
|---|---|---|---|---|---|---|
| | | *Lack of adequate airport services* | *Expensive to source components from interstate* | *Small local market* | *Lack of local expertise in the provision of service facilities* | *Remoteness from the major markets of Melb. & Syd.* |
| 23. | Manufacture of Printed Circuit Boards | *no disadvantages noted* | | | | |
| 24. | Manufacture of Printed Circuit Boards | *no disadvantages noted* | | | | |
| 25. | Manufacture of Printed Circuit Boards | *no disadvantages noted* | | | | |
| 26. | Manufacture of Printed Circuit Boards | | | ✓ | | ✓ |
| 27. | Production of safety switches and safety circuits for hospitals | | ✓ | | | |
| 28. | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities | | | | ✓ | ✓ |
| 29. | Software design; building and testing of various prototypes for the defence industry | *no disadvantages noted* | | | | |
| 30. | Design and manufacture of laser based products | | | ✓ | | ✓ |
| 31. | Design and manufacture of laser based products | ✓ | ✓ | | | |
| 32. | Development and manufacture of safety systems for cranes | *no disadvantages noted* | | | | |
| 33. | Manufacture of computer memories, computer hardware and monitors | *no disadvantages noted* | | | | |
| 34. | Manufacture of computer memories, computer hardware and monitors | ✓ | ✓ | | ✓ | |
| 35. | Manufacture of computer memories, computer hardware and monitors | ✓ | | | | ✓ |
| 36. | Manufacture of computer memories, computer hardware and monitors | *no disadvantages noted* | | | | |

*Appendix F: Disadvantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF LOCATING IN ADELAIDE | | | | |
|---|---|---|---|---|---|---|
| | | *Lack of adequate airport services* | *Expensive to source components from interstate* | *Small local market* | *Lack of local expertise in the provision of service facilities* | *Remoteness from the major markets of Melb. & Syd.* |
| 37. | Manufacture of computer memories, computer hardware and monitors | *no disadvantages noted* | | | | |
| 38. | Consultancy work for the defence industry | | | | | ✓ |
| 39. | Development of communication equipment and the manufacturing of prototypes | ✓ | ✓ | | ✓ | |
| 40. | Design of specialised controllers and all associated software | | | ✓ | | ✓ |
| 41. | Design of radio frequency systems tags, eg for the Sydney Road Authority | | | ✓ | | ✓ |
| 42. | Manufacture of electronic components for car manufacturers and also for the telecommunications industry | *no disadvantages noted* | | | | |
| 43. | Design, development and manufacture of electronic metal detectors, ranging from amateur to military applications | ✓ | ✓ | | | ✓ |
| 44. | Design, development and installation of electronic engine management systems | | | | ✓ | |
| 45. | Production of master compact disks and making of copies | | | ✓ | | ✓ |
| 46. | Design and manufacture of microwave communications systems | | | ✓ | | |
| 47. | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications | ✓ | | ✓ | | |
| 48. | Manufacture of portable moisture sensors for the agriculture industry | *no disadvantages noted* | | | | |
| 49. | Development of monitoring equipment for rainfall, water quality etc. | *no disadvantages noted* | | | | |
| 50. | Development of monitoring equipment for rainfall, water quality etc. | ✓ | ✓ | | | ✓ |
| 51. | Design of silicon chips and integrated circuits | | | | | ✓ |

*Appendix F: Disadvantages of Adelaide as a Location for High Technology Firms (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF LOCATING IN ADELAIDE | | | | |
|---|---|---|---|---|---|---|
| | | *Lack of adequate airport services* | *Expensive to source components from interstate* | *Small local market* | *Lack of local expertise in the provision of service facilities* | *Remoteness from the major markets of Melb. & Syd.* |
| 52. | Design of custom electronic systems | | ✓ | ✓ | | ✓ |
| 53. | Design of electronic products for customers on a one-off basis | | | ✓ | | ✓ |
| 54. | Sub-contracted electronics assembly and in-house design of various items | | | | | ✓ |
| 55. | Design of data logging equipment, mainly for government utilities | | | ✓ | | |
| 56. | Design of data logging equipment, mainly for government utilities | *no disadvantages noted* | | | | |
| 57. | Design of data logging equipment, mainly for government utilities | *no disadvantages noted* | | | | |
| 58. | Design and manufacture of telecommunications equipment to fill niches not covered by Telecom, eg specialised intercom and pager systems | | | ✓ | | ✓ |
| 59. | Alterations of security equipment to suit specific applications | *no disadvantages noted* | | | | |
| 60. | Design work for the Department of Defence; in-house development of defence oriented equipment | | | ✓ | ✓ | ✓ |
| 61. | Redesign of ageing electronic equipment to reduce costs and increase functions; data communications in a factory environment | ✓ | | ✓ | | |

Source: Data from Questionnaire

## *APPENDIX G: ADVANTAGES OF FIRMS' PRESENT LOCATION IN ADELAIDE*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Close proximity to city and airport* | *Close to place of residence of managing director* | *Close to various suppliers* | *Modern buildings and good facilities at reasonable cost* | *Room for future expansion* | *Company owns the site and it is too costly to move* | *Close to parent company or university; high tech image* |
| | ***FIRMS LOCATED IN THE CENTRAL REGION*** | | | | | | | |
| 2. | Design and manufacture of irrigation equipment | ✓ | | ✓ | ✓ | | | |
| 8. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | ✓ | | | ✓ | | | |
| 10. | Design and manufacture of precision weighing instruments, load cells & digital controllers | ✓ | | | | | | |
| 12. | Development of monitoring equipment for the mining industry and software development needed to run the given equipment | ✓ | | ✓ | | | | |
| 13. | Design and manufacture of time management clocks and all associated software | ✓ | | | ✓ | | | |
| 15. | Design and development of computer controlled air conditioning systems for hospitals etc. | ✓ | | ✓ | ✓ | | | image |
| 16. | Design and assembly of voice and data communication systems | ✓ | | | | | | |
| 17. | Manufacture and installation of security systems | ✓ | | | | | | |
| 18. | Design and manufacture of process control instrumentation | ✓ | | | ✓ | | | |
| 19. | Design and manufacture of process control instrumentation | ✓ | ✓ | | | | | |
| 20. | Manufacture of Printed Circuit Boards | ✓ | | ✓ | | | | |
| 21. | Manufacture of Printed Circuit Boards | | | ✓ | ✓ | | ✓ | |
| 24. | Manufacture of Printed Circuit Boards | ✓ | | | ✓ | | | |
| 26. | Manufacture of Printed Circuit Boards | ✓ | | ✓ | | | | |

*Appendix G: Advantages of Firms' Present Location in Adelaide (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Close proximity to city and airport* | *Close to place of residence of managing director* | *Close to various suppliers* | *Modern buildings and good facilities at reasonable cost* | *Room for future expansion* | *Company owns the site and it is too costly to move* | *Close to parent company or university; high tech image* |
| 27. | Production of safety switches and safety circuits for hospitals | ✓ | | ✓ | | | ✓ | parent co. |
| 30. | Design and manufacture of laser based products | | | ✓ | ✓ | | | |
| 31. | Design and manufacture of laser based products | | ✓ | | ✓ | | | |
| 32. | Development and manufacture of safety systems for cranes | | | ✓ | | | ✓ | |
| 33. | Manufacture of computer memories, computer hardware and monitors | ✓ | | | ✓ | ✓ | | |
| 34. | Manufacture of computer memories, computer hardware and monitors | ✓ | | ✓ | | | | image |
| 38. | Consultancy work for the defence industry | ✓ | | | ✓ | | ✓ | |
| 39. | Development of communication equipment and the manufacturing of prototypes | ✓ | | ✓ | | | | |
| 40. | Design of specialised controllers and all associated software | ✓ | ✓ | ✓ | ✓ | | | |
| 41. | Design of radio frequency systems tags, eg for the Sydney Road Authority | | | | | | | university |
| 43. | Design, development and manufacture of electronic metal detectors, ranging from amateur to military applications | ✓ | ✓ | ✓ | | | | |
| 44. | Design, development and installation of electronic engine management systems | | | ✓ | ✓ | | | university |
| 45. | Production of master compact disks and making of copies | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| 46. | Design and manufacture of microwave communications systems | ✓ | | | | | ✓ | |
| 47. | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications | | ✓ | | | | | |
| 48. | Manufacture of portable moisture sensors for the agriculture industry | | ✓ | | | | | |
| 49. | Development of monitoring equipment for rainfall, water quality etc. | ✓ | | ✓ | ✓ | | | |

*Appendix G: Advantages of Firms' Present Location in Adelaide (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Close proximity to city and airport* | *Close to place of residence of managing director* | *Close to various suppliers* | *Modern buildings and good facilities at reasonable cost* | *Room for future expansion* | *Company owns the site and it is too costly to move* | *Close to parent company or university; high tech image* |
| 52. | Design of custom electronic systems | ✓ | ✓ | | | | | |
| 58. | Design and manufacture of telecommunications equipment to fill niches not covered by Telecom, eg specialised intercom and pager systems | ✓ | | | ✓ | ✓ | | image |
| 59. | Alterations of security equipment to suit specific applications | | | ✓ | | | ✓ | |
| 61. | Redesign of ageing electronic equipment to reduce costs and increase functions; data communications in a factory environment | ✓ | ✓ | | ✓ | | | |
| | ***FIRMS LOCATED IN THE NORTHERN REGION*** | | | | | | | |
| 3. | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post | | | ✓ | | ✓ | | image |
| 5. | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) | | | | | | | image |
| 7. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | | | ✓ | | | | image |
| 14. | Development of radio frequency technology; systems engineering | | | ✓ | ✓ | | | |
| 23. | Manufacture of Printed Circuit Boards | | ✓ | ✓ | ✓ | ✓ | | |
| 25. | Manufacture of Printed Circuit Boards | | | | | | | image |
| 29. | Software design; building and testing of various prototypes for the defence industry | | | ✓ | | | | image & universtiy |
| 35. | Manufacture of computer memories, computer hardware and monitors | *no advantages noted* | | | | | | |

*Appendix G: Advantages of Firms' Present Location in Adelaide (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Close proximity to city and airport* | *Close to place of residence of managing director* | *Close to various suppliers* | *Modern buildings and good facilities at reasonable cost* | *Room for future expansion* | *Company owns the site and it is too costly to move* | *Close to parent company or university; high tech image* |
| 36. | Manufacture of computer memories, computer hardware and monitors | | | | | | | image |
| 37. | Manufacture of computer memories, computer hardware and monitors | *no advantages noted* | | | | | | |
| 51. | Design of silicon chips and integrated circuits | ✓ | | ✓ | | | | |
| 53. | Design of electronic products for customers on a one-off basis | ✓ | ✓ | | | | ✓ | |
| 57. | Design of data logging equipment, mainly for government utilities | ✓ | | ✓ | | | | |
| 60. | Design work for the Department of Defence; in-house development of defence oriented equipment | | | ✓ | | | | university |
| | ***FIRMS LOCATED OUTSIDE THE TWO MAIN AGGLOMERATIONS*** | | | | | | | |
| 1. | Design and manufacture of communication equipment | | | | | ✓ | ✓ | |
| 4. | Design and manufacture of electronic components and engine management systems | | | | ✓ | ✓ | ✓ | |
| 6. | Manufacture of remote control door opening controllers | | ✓ | | ✓ | | | |
| 9. | Design and manufacture of electronic speed controllers for evaporative air conditioners | ✓ | | | | | | image |
| 11. | Development of load cells, crane weighing systems and their manufacture | | | ✓ | | ✓ | ✓ | |
| 22. | Manufacture of Printed Circuit Boards | *no advantages noted* | | | | | | |
| 28. | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities | ✓ | | ✓ | | ✓ | | |

*Appendix G: Advantages of Firms' Present Location in Adelaide (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | ADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Close proximity to city and airport* | *Close to place of residence of managing director* | *Close to various suppliers* | *Modern buildings and good facilities at reasonable cost* | *Room for future expansion* | *Company owns the site and it is too costly to move* | *Close to parent company or university; high tech image* |
| 42. | Manufacture of electronic components for car manufacturers and also for the telecommunications industry | | ✓ | | ✓ | | | |
| 50. | Development of monitoring equipment for rainfall, water quality etc. | | | | ✓ | ✓ | | |
| 54. | Sub-contracted electronics assembly and in-house design of various items | | ✓ | | | | | |
| 55. | Design of data logging equipment, mainly for government utilities | | ✓ | | | | | |
| 56. | Design of data logging equipment, mainly for government utilities | | ✓ | | | | | |

Source: Data from Questionnaire

## *APPENDIX H: DISADVANTAGES OF FIRMS' PRESENT LOCATION IN ADELAIDE*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Premesis too old and too small; no room for expansion* | *Remote from the city and the airport - takes longer to get to meetings* | *Rent very expensive for the poor quality of premesis* | *Isolated from other businesses eg. banks* | *Located too far from the city; many customers do not want to make the trip* | *Frequent legal problems with local Council* | *Business located on main road - too much noise and pollution* |
| | ***FIRMS LOCATED IN THE CENTRAL REGION*** | | | | | | | |
| 10. | Design and manufacture of precision weighing instruments, load cells & digital controllers | | | | | | ✓ | |
| 32. | Development and manufacture of safety systems for cranes | ✓ | | | | | | |
| 39. | Development of communication equipment and the manufacturing of prototypes | | | | | | | ✓ |
| 47. | Development and manufacture of ultrasonic and electrolytic cleaners for various industrial applications | ✓ | | | | | | |
| 49. | Development of monitoring equipment for rainfall, water quality etc. | ✓ | | | | | | |
| 52. | Design of custom electronic systems | ✓ | | | | | | |
| | ***FIRMS LOCATED IN THE NORTHERN REGION*** | | | | | | | |
| 3. | Security communications systems; team simulator facilities for defence purposes and automatic postal sorting machines for Australia Post | | ✓ | | | | | |
| 5. | Design and development of multifunction command software, for use in radar and sonar systems (mainly for defence purposes) | | ✓ | ✓ | | | | |
| 7. | Design of Printed Circuit Boards, loading of PCBs and building of final electronic products | | ✓ | | ✓ | | | |

*Appendix H: Disadvantages of Firms' Present Location in Adelaide (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Premesis too old and too small; no room for expansion* | *Remote from the city and the airport - takes longer to get to meetings* | *Rent very expensive for the poor quality of premesis* | *Isolated from other businesses eg. banks* | *Located too far from the city; many customers do not want to make the trip* | *Frequent legal problems with local Council* | *Business located on main road - too much noise and pollution* |
| 14. | Development of radio frequency technology; systems engineering | | | ✓ | | | | |
| 25. | Manufacture of Printed Circuit Boards | | | ✓ | | | | |
| 29. | Software design; building and testing of various prototypes for the defence industry | | | ✓ | | | | |
| 35. | Manufacture of computer memories, computer hardware and monitors | | | ✓ | | | | |
| 36. | Manufacture of computer memories, computer hardware and monitors | | ✓ | ✓ | | | | |
| 37. | Manufacture of computer memories, computer hardware and monitors | | | ✓ | | | | |
| 51. | Design of silicon chips and integrated circuits | | ✓ | ✓ | | | | |
| 57. | Design of data logging equipment, mainly for government utilities | | | ✓ | | | | |
| 60. | Design work for the Department of Defence; in-house development of defence oriented equipment | | | ✓ | | | | |
| | ***FIRMS LOCATED OUTSIDE THE TWO MAIN AGGLOMERATIONS*** | | | | | | | |
| 11. | Development of load cells, crane weighing systems and their manufacture | ✓ | | | | | | |
| 22. | Manufacture of Printed Circuit Boards | ✓ | | | | | | |
| 28. | Design and manufacture of products to assist disabled people and the modification of electronic equipment to suit people with disabilities | ✓ | | ✓ | | | | |
| 50. | Development of monitoring equipment for rainfall, water quality etc. | ✓ | ✓ | | | | | |

*Appendix H: Disadvantages of Firms' Present Location in Adelaide (continued...)*

| FIRM NO. | SERVICE AND/OR PRODUCT DESCRIPTION | DISADVANTAGES OF THE PRESENT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *Premesis too old and too small; no room for expansion* | *Remote from the city and the airport - takes longer to get to meetings* | *Rent very expensive for the poor quality of premesis* | *Isolated from other businesses eg. banks* | *Located too far from the city; many customers do not want to make the trip* | *Frequent legal problems with local Council* | *Business located on main road - too much noise and pollution* |
| 54. | Sub-contracted electronics assembly and in-house design of various items | ✓ | | | | | | |
| 55. | Design of data logging equipment, mainly for government utilities | ✓ | | | | ✓ | | |
| 56. | Design of data logging equipment, mainly for government utilities | ✓ | | | | | | |

Source: Data from Questionnaire

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