THE ELECTRONICS MANUFACTURING INDUSTRY IN WESTERN AUSTRALIA: TECHNOLOGICAL INNOVATION IN A MIDDLE ECONOMY*

André Morkel
and
John Syme

The electronics manufacturing industry of Western Australia consists of a group of innovative technology-based firms in a regional middle economy. Four basic strategies were identified where local manufacture and local technological entrepreneurs are able to develop viable businesses with little or no protection and only modest (if any) government support. The circumstances of the firm's establishment, whether market driven, technology driven, capital driven or oriented towards local business only, persisted in shaping the strategic orientation of the company, at least in the present stages of the industry. The companies do not compete directly with multinationals in consumer markets, but rather are oriented towards specialised industrial markets using niche strategies.

Keywords: electronics, Western Australia, manufacturing, technological innovation

INTRODUCTION

A number of countries, such as Australia, fall in a middle category as far as their manufacturing and certain other industries are concerned. These countries resemble large industrialised economies, such as the US, in terms of life style, income per capita, consumption patterns, education, infrastructure services and other criteria. Their manufacturing industries, however, exhibit different characteristics. Innovative and technologically sophisticated industries in these countries are dominated by foreign companies and much of the local manufacturing industry, even on local markets, is often uncompetitive.[1]

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Australia, and, at a regional level, Western Australia, are good examples of such middle economies. A study of the local electronics manufacturing industry in Western Australia showed a small but active manufacturing industry with several companies already exporting vigorously and with others soon to join them. A closer examination of these companies and their characteristics is of greater than local interest. They are examples of manufacturing industries incubating and growing in a hostile and difficult environment. Many other middle economies and regions with few natural advantages in manufacturing have similar challenges and opportunities. This is in contrast to clusters of small firms in larger economies which may have substantial locational advantages.[2]

The purpose here is to understand the underlying dynamics, elements and interrelationships that enabled this industry to become established and to develop against the odds.

INDUSTRY CHARACTERISTICS

Data were initially collected in two separate industry studies, the first in May 1984, and the second in October 1985. The first survey established and recorded the basic structure and characteristics of the industry. An attempt was made via a structured interview to collect information from all firms in the industry. It was estimated that the industry contained 83 firms at this time and data were collected from 60 (72 per cent) of them. The second study was oriented towards understanding the competitive dynamics and strategies of the industry. This study also updated the earlier survey and included detailed interviews with a small number of firms. It is estimated that there were then 87 firms in the industry and information was sought via a mail questionnaire. Reports were received from 72 firms, a response of 83 per cent. Additional information about the non-responding firms available to the study team indicated that the surveys were broadly representative of the industry as a whole. Eleven firms were studied in greater detail. They were identified from information gathered in the first survey and were chosen as being representative of the leading and better developed firms in the industry. These 'exemplar' firms were examined to determine how they were established, how they developed, what strategies they adopted, their products and the manner in which they approached their different and diverse markets.

The study showed that the local manufacturers consisted almost entirely of small, independent and locally owned companies. There is no manufacturing within the state by large national or multinational companies. The first survey showed that ownership of firms is predominantly local, with only one firm in the sample having a majority of ownership outside the state. Fifty-seven firms provided

information on ownership and control. Of these, 90 per cent were fully independent in management policy and control, the remainder being subsidiaries of other companies with local autonomy. In the time between the two surveys, a substantial number of firms (16) had obtained additional capital through public listing on either the main or second boards of the stock exchange.

The companies are very small by any standard, but are showing signs of growth. The mean number of employees per firm increased from 17.7 to 19.7 between the two surveys, an increase of 16.5 per cent over the period. Approximately half of the companies in the second survey reported more than a 25 per cent increase over the previous year in the level of electronics hardware manufacturing activity, 21 per cent increased more than 100 per cent. Only 10 per cent of companies expected a growth of this magnitude in the 1984 survey. There was a general feeling of optimism in the industry and 84 per cent of the companies expected to grow by more than 25 per cent in 1985/86 with 36 per cent expecting to more than double their sales. Annual production ranged from one to 30,000 units with a median of 40 compared with a median of 32 in 1984. Unit selling prices ranged from \$1 to \$600,000 with a median of \$2,000 and a mean of \$28,271.

The industry is overwhelmingly geared to the manufacture of products for industrial markets. This trend is continuing as is shown in Table 1.

TABLE 1
USE OF PRODUCTS

	1984 Survey	1985 Survey	
Use of product	Percentage of total estimated industry sales revenue 1983/84	Percentage of total estimated industry sales revenue 1984/85	Cumulative percentage of total sales
Components and sub-assemblies	17.7	16.8	16.8
Industrial or commercial end users	68.9	76.6	93.4
Domestic consumers	13.4	6.6	100.0
Total	100	100	
Sample size	41	49	

The single most important customer industry in 1985 was the mining industry, accounting for 35 per cent of total industry revenue, followed by manufacturing industry (19 per cent) and government administration and utilities (16 per cent) (Table 2). In the period between the surveys, the location of customers changed significantly towards a greater emphasis on sales outside the state (Table 3). The table shows a decline in the importance of Western Australian markets with an increase in overseas sales, in particular to Asian and European markets. There has been a small increase in the proportion of sales to other states of Australia, but this trade is becoming concentrated in the hands of a smaller number of firms.

TABLE 2
SALES BY MARKET SEGMENT

	1984 Survey	1985 Survey
Market segment	Percentage of total revenue	Percentage of total revenue
1. Government — military	0.6	1.2
2. Other government	20.8	16.2
3. Retailer/wholesalers (primarily for on sale to consumers)	7.0	8.4
4. Medical and scientific	4.0	0.9
5. Commerce and services	7.2	6.8
6. Building and construction	1.4	2.9
7. Manufacturing industry	22.1	18.9
8. Communications	2.7	0.7
9. Agricultural and non-mining	4.8	2.2
10. Mining and quarrying	18.6	35.5
11. Other	10.8	6.3
Total	100	100

TABLE 3
SALES LOCATIONS

	1984 Survey	1985 Survey
Location	Percentage of sales in location	Percentage of sales in location
Western Australia	65	38
Elsewhere in Australia	27	37
Overseas — Asia	4.5	18.5
— Europe	1.3	4
— USA/Canada	1.4	0.5
— Other	0.2	2
	99.4	100

Note: 'Other' included sales to New Zealand, Zimbabwe and the Pacific Islands.

This study is of firms manufacturing within Western Australia. However, some manufacturing is also done outside the state. Of the 57 firms providing information on manufacturing location, 46 per cent manufactured or had manufactured some of their product outside Western Australia. Where manufacture took place elsewhere in Australia, on average, it accounted for 21 per cent of the value of total output of the firm. Of the twenty-two firms manufacturing elsewhere in Australia, four firms expected this proportion to rise in the next two years, although four firms anticipated a decrease. Only three firms not currently manufacturing outside Western Australia planned to commence manufacturing elsewhere in Australia.

The position was somewhat different with respect to overseas manufacture. This represented an average of 30 per cent by value of the total output of those firms already manufacturing overseas. Fourteen expected their proportion to increase while only two expected a decrease. Eleven of the thirty companies currently manufacturing entirely within Western Australia indicated an intention to commence manufacturing overseas in the near future. A further two firms were currently considering this option.

The results indicate that when manufacturing is performed outside Western Australia, increasingly the trend is towards offshore manufacture. Given the strong growth rate of the industry, the indications are that local manufacture will continue to increase, concentrating particularly on manufacturing during earlier stages of product development and to meet smaller batch requirements.

VIABLE BUSINESS STRATEGIES

It is useful to first briefly examine the nature and categories of manufacturing activity which are not likely to be viable in Western Australia. The source of competitive advantage for a company operating in Western Australia will not be low factor costs, as may be found in low labour cost countries, nor will it involve easy access to mainstream markets where major economies of scale are possible, as may be found in the larger economies. As a first principle, an activity is unlikely to be appropriate for Western Australian electronics companies if it mainly relies on:

- low factor costs; or
- major economies of scale in manufacturing; or
- major economies of scale in distribution, promotion and other aspects of marketing; or
- aggressive direct competition against large national and international companies.

Mainstream manufacturing activities for consumer, industrial or government markets are unlikely to be viable in Western Australia unless some other basis for competitive advantage can be found. Technological invention and innovation could, conceptually, provide that competitive advantage, even in mainstream consumer markets. However, the task of developing such worldwide mainstream consumer markets from a Western Australian base would be very great. The traditional route of own manufacture, marketing and growth internationally would not be a viable option and a Western Australian company attempting this would soon be overtaken by powerful competitors.

In spite of the many barriers and handicaps imposed by the location, local entrepreneurs operate in several specialised areas where they have opportunities for competitive success. Although these all tend to be small and specialised niche strategies, they are of interest to identify and study. There are, however, many activities outside the major mainstream markets where Western Australian electronics manufacturers can establish a competitive advantage and thus form the basis for a viable economic activity. These activities might be classified into four primary groups. There are examples from each of these groups in various stages of development in the Western Australian industry. The leading companies within each group are still in early stages of growth and have yet to display characteristics of a mature organisation. The categories are:

1. Market Driven, Export Potential
These are specialised activities initially relying on a local customer of world standing, where significant design, research and development are required. They rely initially on the requirements of major customers in the local market, and to that extent are market driven. Products they develop would also have markets outside the state, and generally outside Australia, and therefore these activities could become export oriented at a relatively early stage of the company's development.

2. Technology Driven, Export Oriented
Highly innovative activities based on inventions of creative individuals. These activities are based on the work of technologically innovative individuals in Western Australia and are often oriented towards general market needs rather than special local requirements. They can therefore be characterised as technology or invention driven and export oriented.

3. Capital Driven, Export Oriented
Specialised activities relying on a spread of small international markets. These activities derive no particular advantage by operating from a local base, but neither does a Western Australian location

cause major disadvantages. They arise from the activities of business oriented, rather than technology oriented, entrepreneurs. They require relatively large amounts of capital investment early in their development. They can thus be characterised as capital driven and export oriented.

4. Local Market Oriented
Activities servicing local markets relying on a location advantage. These generally confine their activities to their natural market base and do not actively seek national or international expansion.

A breakup according to these categories of the 72 firms providing information is:

Export Oriented Firms	
Category 1 (Market Driven)	21 firms
Category 2 (Technology Driven)	15 firms
Category 3 (Capital Driven)	4 firms
Local Market Oriented Firms	
Category 4	32 firms

The circumstances under which a company is formed, and the skills and ambitions of the individuals instrumental in its formation, have a profound effect on a company and its future development for long after it is established. The companies in each of these categories exhibit different and distinct paradigms of development and strategic advantage, even though they may grow to resemble one another as they mature over time. It is contended that this taxonomy represents a reasonably comprehensive listing of the types of electronics hardware manufacturing activity likely to be competitive, in both local and international terms, from a Western Australian base, and that activities outside these categories are unlikely to be successful.

CATEGORY 1: MARKET DRIVEN, EXPORT POTENTIAL FIRMS

The availability of substantial local customers is important for small local companies for several reasons. The close proximity of a major customer with a substantial, specialised need provides the contact, interaction and feedback necessary for product development. New products are developed in response to the needs of these major clients. Generally, by the time the product is ready for world marketing it has been through an extensive refinement and testing process based upon feedback from the major customer. For such a process to proceed, it is important to have competent engineers within these large client organisations. They should have sufficient ability and opportunity to seek new solutions and to do original development work requiring novel instruments and testing facilities. Lesser engineers will tend to

play safe and to buy existing solutions and equipment from large multinational suppliers. Substantial local customers also provide credibility for future sales. If a company has made sales to, for instance, large local mining companies who are of world standing in their own field, then it has greatly enhanced credibility when operating outside the state.

Initially the products of companies within Category 1 are likely to be highly customised and made in relatively low volumes. Being engineered solutions to specialised industrial problems, development and manufacturing costs can be recovered by the small local R & D/manufacturing company. They tend to be good engineering solutions using up-to-date, but not necessarily completely novel, technology. The basis of competitive advantage lies in the novel engineering solution to a particular problem, rather than a unique invention. Often the products include specialised software. The initial engineering and problem solving emphasis of the company means that early examples of the products are well-engineered, but with room for improvement in presentation. This would include industrial design, packaging, proper documentation and instruction manuals.

The manufacturing requirements of these products, which are typically highly complex with a high unit cost and low volume, are highly skilled labour but often relatively low capital investment in production technology. Often the design engineer will be closely involved with the manufacture of the product. These products are very suitable for local manufacture. In time, as markets grow locally and internationally, these products become increasingly standardised, perhaps with a range of options or modifications available. The extent to which local manufacature is undertaken will depend to a large extent on the complexity of the product and the likely production volumes. If there remains a high degree of customisation and a high unit selling cost, then the product is more likely to be manufactured and marketed from a local base, while with increasing standardisation and volume some manufacturing could shift overseas.

In some circumstances, coalitions with international companies can be an important means of gaining market credibility, market access and/or international marketing skills. Coalitions can take a number of forms, with the international company assuming a variety of roles including customer, international or regional marketing agent, licensee and partner in joint ventures for marketing and manufacturing. The coalition partners are not necessarily electronics companies, but might be general equipment companies providing the major systems or subsystems for larger overseas purchasers. Such coalitions can provide contacts, credibility and access to marketing and service skill for the ongoing business.

Initial funds for product development in these companies often come from contract research income. These companies achieve relatively easy entry into manufacturing via consulting and contract research for large clients.[3] Research contracts may be with clients or sponsored by government, and may be in conjunction with government research and development grants. Therefore, important early sources of finance will be internal funds, contract research income and research grants. Growth tends to be relatively modest, at least in early years, where it is driven by the pace at which consulting and contract R & D work is undertaken. Expansion in this phase can occur with fairly small amounts of private capital. When their products are fairly well developed and ready for international marketing, they are able to raise additional finance based upon an established business track record, well developed products, and the possibility of international buyer interest and contracts. Such external financing, whether from venture capital sources or the stock market, can thus be obtained under favourable conditions.

CATEGORY 2: TECHNOLOGY DRIVEN, EXPORT ORIENTED FIRMS

These are highly innovative companies arising from the work of technologically inventive individuals. These companies, in common with those discussed as Category 3 (capital driven, export oriented) firms, have few direct strategic links with the mainstream local economy. This is in direct contrast to the market driven firms previously described where particular local requirements are central to product and company development. This type of company is located in Western Australia because the key inventors and entrepreneurs choose to live there. The products these individuals develop can range from very specialised niche products to products oriented to large scale mainstream markets, normally not considered appropriate for manufacture in Australia. Examples in Western Australia include encryption devices, moving electronic signs, an advanced parallel processing computer and a novel storage/retrieval technology for visual and digital information.

Products produced by this group of innovators could potentially have large and worldwide markets. They may be an innovative solution to a new problem, and have to have a new market created, or a new solution to an old problem, and have to enter and displace existing products in existing markets. In the latter case, in particular, there could be substantial and entrenched investment in established technology to overcome. Companies in this group, if they have attractive technologies, are vulnerable to competitive pressures or takeover bids from large companies.

These entrepreneurial inventions are typically developed by the inventor/entrepreneur leading a small team in small companies. The group can act with considerable autonomy, it can cross disciplinary boundaries and can tackle old problems with fresh solutions. However, the business skills and financial resources required to launch these companies at adequate levels of operation can result in moving the inventor into a technical development role, with the general management provided by more experienced business managers. The early examples in Western Australia have so far originated from individual inventors, who proceeded to assemble an R & D team of graduate engineers to work on the further development and refinement of the invention. While the tertiary institutions of the area have not yet yielded many new companies, a few are emerging from R & D work at the University of Western Australia. Local manufacture for this group of firms will be appropriate if a 'window of medium market acceptance'[4] is available; that is, the market must be large enough to justify the level of capital investment required, but not so large as to attract active interest from large multinational firms.

If manufacturing is undertaken locally, requirements are for production skills and for a reasonably high level of capital investment. Additionally, regular access to components will be required. Because the products will generally be at the technical state of the art, the need for a well-trained and skilled production workforce may become a constraint, requiring special training or overseas recruitment. If the manufacturing and marketing of the product is undertaken by the local company, it may still be necessary to undertake a certain amount of manufacture offshore. Reasons may include lower factor costs, more sophisticated infrastructure, access to markets where local manufacture is important, and compliance with offset requirements in export markets.

If the product is aimed at larger mainstream markets, requiring high volume production of standardised items, then offshore manufacture will be warranted. Coalition strategies of various types, preferably with an established large company, might be essential. This will provide access to the large company's marketing network and also access to its production skills and capabilities in larger volume manufacturing. The large company will then tend to control the manufacture and marketing of the product with the locally based company being primarily involved in new product research and development.

These enterprises can promise very high and attractive potential returns to early investors in their development, but their risks are commensurately high. The type of funding they will be able to attract will vary according to the stage of product development. In summary,

the types of funds applicable to various stages of product development are:

1. Initial product/idea development

   Initial funds tend to be provided by the developer, relatives and friends, and on occasion by private financiers. Uncertainties and high risks attached to this stage tend to exclude unsecured institutional investment. A fairly long period of research and development is likely to be required, though part of the initial work usually occurs prior to the formal establishment of an enterprise. It would seem important that the objectives and time frame during this phase be constrained only loosely. Research grants can be very important. Funds from private and government organisations, often with their own R & D facilities and requirements, may also have an important role. In some cases, private seed capital can be raised based on promising ideas. However, such private capital will be at the cost of substantial control in the development of the product because of the weak bargaining position of the entrepreneur at this stage.

2. Product/prototype development

   Moderate amounts of capital will be required at this stage. The most appropriate source will be private venture capital able to take a long term view of the project and to provide management and negotiation skills and market intelligence. The successful enterprises in this category of activities have been able to attract capital of this type to take them through to a very well developed stage. Funds from different government arms have been useful here for some enterprises. Financing during the prototype development stage should ideally be from a source that will leave the company free to conduct a full range of negotiations with potential customers at some later stage in the company's development. This is in contrast to advice often given to inventors to develop their invention in partnership with large companies already active in the industry. The pitfall here is the potential conflict and the bureaucratic obstacles which the new development would face from the defenders of the existing products threatened by the new invention. The inventor of a new computer, for example, should not seek a large computer company as a partner at the early product development stages. Rather, his firm needs to remain independent or backed by capital without conflicting interests in order to compete or offer its technology under licence to various companies once the product has been fully developed. The financial strategy of a company will influence its business strategy to a substantial degree. It is important for this type of company not

to seek public subscription too early. It is generally preferable for private venture capital to finance initial prototype production and initial marketing and/or licensing. Public listing can then be sought at some later stage for expansion from a more mature organisational and market base. Private venture capital at this early stage allows for a longer time perspective and patient development work. This is in contrast to public listing, with its associated public scrutiny and expectations of quick returns.

3. Expansion and market development

   Once products are developed and initial markets secured, company expansion and market development can require large amounts of capital and public listing can be appropriate at this stage. Depending on the economies of scale and barriers to market entry involved, the local company must decide whether to seek to manufacture and market its product independently or to seek any of a variety of coalition strategies with large companies. As independent producer, it could pursue offshore manufacturing and international agency arrangements for marketing.

The enterprises will often have been established in Western Australia by people who choose to locate there. While the companies are controlled locally by the inventor/entrepreneur, there will be strong incentives to keep as many activities as possible in Western Australia. As control shifts to financiers and parent companies, particularly when located outside Western Australia, decisions may be taken to move not only manufacturing offshore (which may be appropriate), but also R & D activities. When control is located outside Western Australia, conventional economic logic may often tend to suggest the closure of the Western Australian operations and the transfer of the whole company elsewhere. The availability of local venture capital sources could, therefore, become an important determinant of the extent to which the business remains in the region.

CATEGORY 3: CAPITAL DRIVEN, EXPORT ORIENTED FIRMS

There are manufacturing activities for which there are no particular advantages in a Western Australian location, but neither are there particular disadvantages. Activities of this kind are initiated by business entrepreneurs rather than by engineers solving problems for the local market (as in category 1) or by technological inventors (as in category 2). The technology for the venture need not have a local origin, but will probably be well developed with an identified market before the enterprise is embarked upon. Lifestyle preferences of the key people are important in locating the activity in Western Australia

since these industries are essentially footloose, with few, if any, economic reasons to locate in the region.

To avoid the main disadvantages for a Western Australian operation, such activities must preferably operate in widely spread and specialised international markets and use production technologies which are not overly sensitive to economies of scale. Because the company is operating in the international marketplace, albeit for a specialised product, its manufacturing operations must be efficient and its products and production technology at or near the technical state-of-the-art. Western Australia has relatively high labour rates in international terms and companies of this type are likely to be competitive only if they invest sufficient capital in production technology, and are tightly and efficiently managed.

An example of a company of this type was examined and it is instructive to examine briefly its key features by way of illustration. The company operates one of only five similar plants in the world, producing multiwired circuit boards. Its product is aimed at the low volume, complex end of the general market for circuit boards. The central technology was developed in the research and development laboratories of a much larger American company and is licensed to the Western Australian producer. The company's small size and flexibility enabled it to bring the product onto the market much sooner than the company that developed the product. Using the original technology as a base, it has developed new products and refined its production processes to maintain the competitive advantage afforded by early market entry. The company has invested heavily in automated production processes and is now able to produce five times its current production volume with little or no increase in staff. Experience gained in developing and marketing its current product have enabled it to identify new products which will permit it to maintain its competitive advantage as a producer of high quality, complex, low to medium volume state of the art products. The important generalisations to make are:

(i) that the market for the products is specialised;

(ii) that the markets are spread internationally, and so proximity to any one large market is not a factor in determining competitive advantage; and

(iii) that sufficient capital was able to be marshalled to invest in production technology to enable the delivered cost of the product to be competitive; that is, pocket economies of scale are possible.

These companies are likely to manufacture products which are high quality and technologically complex. This will be necessary to

maintain any competitive advantage the company may establish. When new products are developed by these companies, the choice of manufacturing location will depend on the current manufacturing capacity of the firm, on the nature and structure of the market, the type of product, and whether the necessary capital can be marshalled to fund any additional production equipment and technology. In the longer term, these companies will need to re-invest at appropriate times in modern production technology to maintain a competitive position.

The companies are geared for export from a very early stage and rely on a spread of international markets for their viability. They, therefore, must have well-developed international marketing expertise. The products manufactured are sometimes suitable for inclusion in offset programs and this could provide a point of entry into particular markets for them. Coalitions with companies with a marketing network in overseas markets will be advantageous for many of these companies to provide market strength and market access, but the specialised nature of the products of these companies makes it feasible for the companies to undertake their own marketing.

A major source of capital is necessary to establish the venture. This is a difficult route into manufacture. Initial capital sources almost certainly will be private. These ventures are likely to be relatively risky and therefore not very easy to sell to the public early in their life. It is possible, however, that as the company becomes established and developed, public funds may be sought for further development and to provide a market for the existing capital in the company.

CATEGORY 4: LOCAL MARKET ORIENTED FIRMS.

Some manufacturing activities rely primarily on being located close to local markets and have little ambition or prospects of expanding outside the local market base. For the most part, the scale of these operations is very small. The focus of these firms may range from a merchandiser or consultant modifying or otherwise customising an imported product, through repairs, maintenance and servicing, to jobbing manufacture for local customers. There are, for example, a small number of firms producing printed circuit boards and undertaking low volume assembly mainly for local (Western Australian and other Australian) clients. An additional area of locally oriented manufacturing activity is the assembly of imported sub-assemblies for the local market. In some instances the scale of production in numbers of units can be relatively large, but the output is strictly for local consumption. Generally these products can fairly be said to be at the market, rather than the technical, state of the art.

This group, then, is populated by a mixture of small companies primarily oriented to servicing local needs, and by larger marketing

and distribution operations servicing mainstream markets with largely imported products but performing some local assembly. Since these companies are set up to service the local market, their growth depends on the size of that market. For a smaller specialised market, production can generally be expected to be of low volume, and may, therefore, be relatively labour intensive. The companies rely on location advantage, the small volume requirements of the local market, and the low price elasticity of the product. This enables them to make products in a relatively labour intensive way and still be competitive. When these companies rely entirely on the local market, they may not be able to attain the necessary volumes to justify substantial investment in production technology. Their choices would then seem to be either to maintain their current level of fairly labour intensive, low volume manufacture, or to attempt to find new markets so that a higher level of capital investment in production technology can be justified. If the latter is chosen, they would tend to look a little like category 3 companies and similar factors would apply; that is, the markets they seek would have to be large enough to justify the level of capital investment required, but not so large as to invite substantial competition from more powerful companies. If the companies have a more substantial local market to service, then greater investment in production facilities can be expected. However, companies in this category servicing larger local markets will, by and large, undertake only final system assembly locally, with the major components being imported. These are likely to be standard products from large mainstream international markets and the local manufacturing activity is likely to be minor.

CHOICE OF MANUFACTURING LOCATION

For companies in categories 1, 2 and 3, production location choice can be viewed as a continuum with an imperative for offshore manufacturing at one end and an imperative for local manufacturing at the other. Whether a product should be manufactured locally or offshore will depend on factors particular to the product. Local manufacture will be favoured:

- when the product is large, expensive and complex
- where quality control is important
- where the product is produced in small volumes
- where access to the designer of the product during the manufacturing process is important
- where security of design is a factor
- where margins are sufficiently high to justify local manufacture
- where local decisions are made with a high degree of local sovereignty

TABLE 4

SUMMARY OF APPROPRIATE ACTIVITIES

	Category 1 Market driven, export oriented	Category 2 Technology driven, export oriented	Category 3 Capital driven, export oriented	Category 4 Local market oriented
Major focus or characteristic	Local markets where customers may be of world standing — mining, agriculture, telecommunications, government, transport, health.	New technological invention.	Entrepreneurial business decision to locate footloose technology-based company locally.	Servicing local markets; small companies.
Manufacturing	Highly customised low volume in early stages. High value. Might need industrial design and documentation. Very suitable for local manufacture standard-isation trend.	Windows of medium market acceptance for local manufacture. For mainstream products, manufacturing would be offshore. Coalition strategies.	State of art. Utilising local or imported technology. Pocket economies of scale.	Modest modifying and small scale manufacture. Small volume customised products, often modified from imported base.
Marketing	Direct contact important with client of world standing. Credibility important. Coalitions for international marketing and representation.	Need to develop market for new product. Coalition marketing by larger companies. Licensing.	International specialised market.	Local customers.
Finance	Early funds internal. Consulting, R & D grants, easy entry.	Initial idea/product development. Own funds. Private venture capital. Expansion. Public float.	Venture capitalists. Later public float.	Own finance.
Personnel	Consulting and contract staff. R & D team important. Problems of using abilities distributed within the group.	Inventor assisted by R & D team working on product development. Negotiating and business skills important	Professional managers and manufacturing/ marketing team. Modest R & D (if any).	Modest R & D. Mainly trading, consulting and service personnel.

Offshore manufacture will be indicated:

- when the production process is labour intensive
- where the volumes produced are large in world terms and the product is standardised
- where, to gain access to a market, production in that marketplace is necessary
- where issues of market power are important

It is important to note that there is a zone of indifference on this spectrum where a decision can be made to manufacture either locally or offshore. The outcome of this decision will depend largely:

- on the level of capital investment in place or able to be provided by the local firm
- the production skills available to the enterprise
- the nature of the advice obtained and the analysis that goes into making the production location decision
- the lifestyle and personal location preferences of key decision makers

Such a decision is not always an easy one — it can be quite a complex analysis and is a relatively new one for many Western Australian companies to face. There is often a presupposition that it is cheaper to manufacture offshore in the absence of any advice to the contrary. In many cases, however, with the right sort of information, planning and investment, local manufacture can be justified. It is worth noting, for example, that cost levels in some of the traditional locations for offshore manufacture, most notably Singapore, appear to be rising.

CONCLUDING REMARKS

This study has identified the characteristics and viable strategies of the electronics hardware industry in Western Australia as an example of a group of innovative technology-based manufacturing firms in a regional middle economy. Conventional wisdom is inadequate to explain this industry. In spite of the very substantial barriers to innovation and manufacturing in Australia, a small but viable electronics manufacturing industry is emerging. There are many major areas of the industry where local manufacture is likely to be completely uncompetitive. In fact, businesses which traditional strategy analysis would indicate are attractive opportunities with large and rapidly growing demand, are likely to be the very areas for companies in the middle economies to avoid. In these areas only large and powerful multinational companies can compete.

The study outlines four strategies where manufacture and local technological entrepreneurs could have at least some chance of developing viable businesses with little protection and only modest

levels of government support. Examples in all four categories were identified in Western Australia and early indications show the development of a small but vigorous industry in which successful companies are showing rapid growth. This study is of more than parochial interest as an example of technological innovation under conditions which traditionally would be considered to be very difficult.

NOTES AND REFERENCES

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