Technology and Innovation Management

Analysis of
the New Zealand Plastics Industry —
Technology Status, Problems and Opportunities

A thesis presented in partial fulfilment of the requirements for the degree of Master of Technology in Production Technology at Massey University

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Abstract

The aim of this thesis is to evaluate the status of innovation and technology management in the New Zealand plastics industry using a survey.

This thesis provides a comparison of plastics manufacturing capability in New Zealand and in other industrial countries; it also provides an examination of key trends, attitudes and problems within the New Zealand plastics industry to indicate where technology transfer from overseas, or research and development may be required.

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Chapter 1
Introduction

It is widely recognised that New Zealand can't maintain its economic growth if it can't compete internationally. How to improve New Zealand's competitiveness has become one of the most important topics and a number of relevant studies have been carried out recently. A background to New Zealand's economy and its competitive advantage can be found in Crocombe (1991)[1]. A comparative overview of manufacturing strategy between New Zealand's companies and overseas companies was provided by Corbett (1991)[2]. Edwards (1992)[3] studied the comparison of R&D spending between New Zealand and industrial countries. Johnston (1992)[4] focused his research on a technology strategy in New Zealand manufacturing industry. Research into manufacturing for New Zealand's prosperity and growth was made by Manufacturing Advisory Group (1992)[5]. An assessment of technology status in the New Zealand electronics industry and footwear industry was provided by Professor Barnes (1992)[6].

The aim of this thesis is to evaluate the status of innovation and technology management in the New Zealand plastics industry using a survey. This thesis provides a comparison of plastics manufacturing capability in New Zealand and in other industrial countries; it also provides an examination of key trends, attitudes and problems within the New Zealand plastics industry to indicate where technology transfer from overseas, or research and development may be required.

In a competitive world economy, innovation and technology management plays an increasingly important role for organizations to produce better goods and services that will compete effectively in the global market. Clark[7] stated that innovations may alter product design, production systems, skills and knowledge base, materials, and capital equipment. In the marketing area, innovations may alter customer bases, customer applications, channels of distribution and service, customer knowledge, and modes of communication. Porter[8] emphasized that technological change is one of the principal drivers of competition. Technological change plays a major role in structural change of existing industry, as well as in creation of new industry.

Chapter 2 discusses the importance of technology and innovation to manufacturing industry. The global economic performance is used as an indicator to show how some industrial countries have achieved their success in the global trade, and how New Zealand's industry has failed to broaden and upgrade its competitive advantages to cope with increasing international competition. In addition, a descriptive and statistical review of the position of manufacturing in New Zealand's economy is used to show that manufacturing has the potential to make an increasing contribution to the country's prosperity. Finally, suggestions are provided to show how New Zealand manufacturing industry can improve its competitiveness in the global trade with innovation and technology management.

Chapter 3 discusses in detail the potential manufacturing improvement through a strategic approach. A crucial determinant of the success of global business strategy is a consistent and matching global manufacturing strategy. This chapter begins with a review of the literature and the principle of manufacturing strategy. The key issues of New Zealand manufacturing industry based on the comparison of manufacturing strategies used by New Zealand's companies and other overseas companies are then summarised.

Chapter 4 begins with a brief review of technology changes and then moves on a description of the world class manufacturing. This includes a description of some major manufacturing technologies: *Computer Integrated Manufacturing (CIM), Manufacturing Resources Planning (MRPII), Just-in-Time (JIT), Total Quality Management (TQM)*, and *Innovation and Technology Management.*

Chapter 5 briefly reviews the plastics industry, which includes constitution of the plastics industry and the situation of the plastics industry in the global economy as well as its development trend.

Chapter 6 describes the survey method and reviews the profiles of the New Zealand plastics industry: *the personnel percentage by company size, technical linkages, investment in technology, product group statistics, and average percentage of product markets.*

Chapter 7 summarises the comments given by survey respondents on a series of key issues in the New Zealand plastics industry: *major problems, problem solutions, the critical technology changes, as well as the importance of tool and die making.*

Chapter 8 provides four pieces of information about the technology assessment of the New Zealand plastics industry: *(1) the assessment of the importance of the particular technology to the products; (2) the assessment of company status relative to the world status; (3) the gap between the importance and status which indicates where technology transfer from overseas, or R&D, may be required; (4) further analysis of major techniques.*

Chapter 9 gathers information on how New Zealand plastics companies assess their competitive characteristics in six areas: *(1) important strategic directions; (2) marketing practices; (3) planning control and appraisal methods; (4) achieving competitive edge; (5) management and engineering systems; (6) supplier management.* In addition, the comparison of ten highly rated issues about the competitive characteristics between New Zealand plastics companies and overseas companies is discussed.

Chapter 10 summarizes the main issues discussed in previous chapters. Conclusion and recommendations are provided.

Chapter 2
The Importance of Technology and Innovation to Manufacturing Industry

2.0 Introduction

The growing worldwide trend of economic restructuring and increasing importance of economic and technological strength has been regarded as an indicator of national power (Porter, 1985)[1]. The pace of technological change and diffusion, specifically the emergence of the new technologies and innovation, has and will increasingly induce significant changes in the international distribution of industrial manufacturing, trade and investment and competitive advantages.

In order to indicate the importance of technology and innovation to manufacturing industry, the global economic performance was used as an indicator to show how some industrial countries have achieved their success in the global trade, and how New Zealand's industry has failed to broaden and upgrade its competitive advantages to cope with increasing international competition. In addition, a descriptive and statistical review of the position of manufacturing in New Zealand's economy was used to show that manufacturing has the potential to make an increasing contribution to the country's prosperity. Finally, the discussion was focused on how New Zealand manufacturing industry could improve its competitiveness in the global trade with technology and innovation management.

2.1 The key elements for achieving competitive advantage

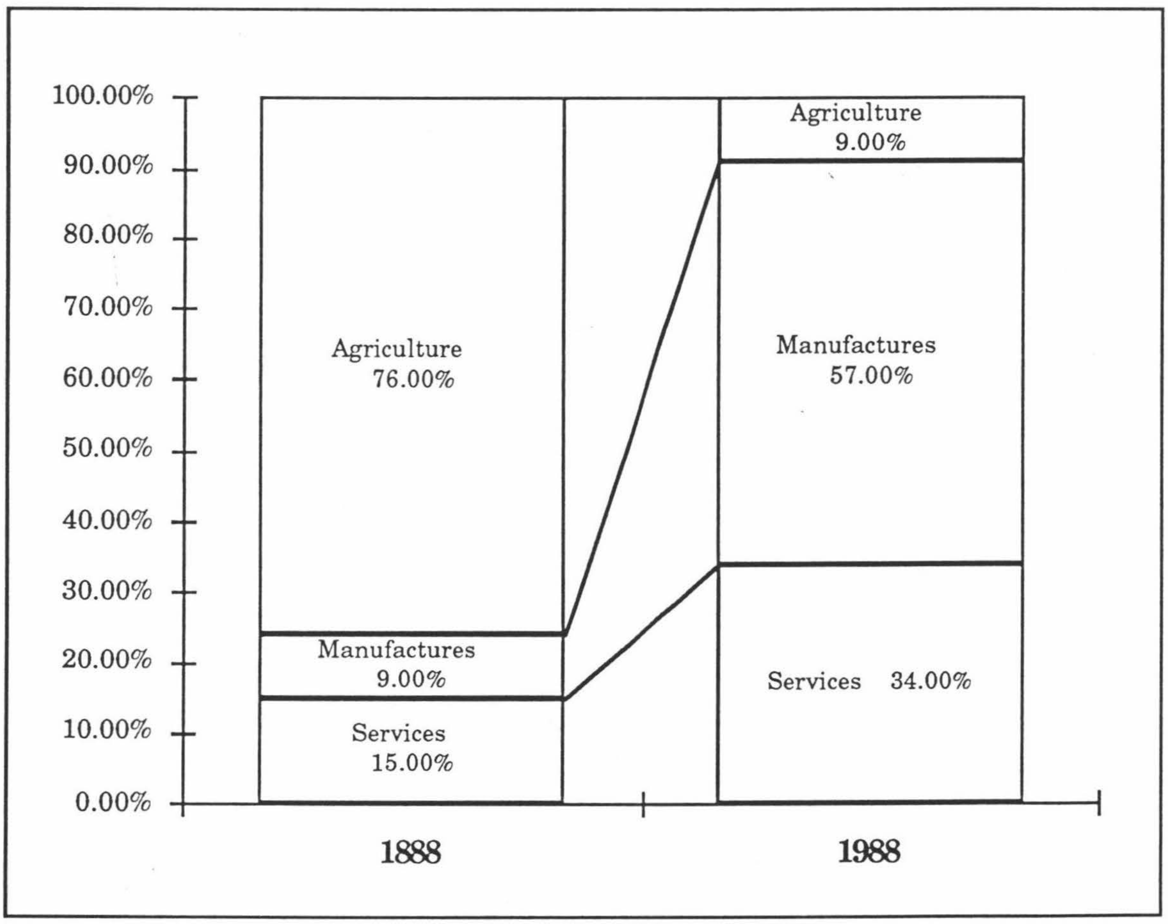
In a recently published book [2], Porter found that companies gain and sustain competitive advantage in international competition through improvement, innovation and upgrading. These are ongoing dynamic processes, not single, once for all events, which demand continuing commitment and investment both to perceive and act upon opportunities. Porter identified four broad key elements for a nation to achieve competitive advantage which can be listed as:

- Factor conditions.
- Demand conditions.
- Related and supporting industries.
- Firm strategy, structure and domestic rivalry.

They are the forces within a nation that provide firms with the pressures, incentives and capabilities to undertake technology change, improvement and innovation.

2.2 Review the change of global trade in manufacturing

Over the last 100 years, the structure of world trade has fundamentally changed. In 1888, 76% of world trade was in agricultural products. By 1988 this has declined to 9% (see Figure 2.1). The major growth has taken place in manufactured goods and, in more recent decades, in services. In the 1980s, growth rates in manufactured exports continued to outstrip growth rates in agricultural exports[3].



Source: GATT Annual Report, 1990

Figure 2.1 The Changing of World Trade

Changes in the composition of world trade have resulted in changes in the fundamental dynamics of trade. In today's global economy, success is a function of a nation's ability to develop competitive advantage in advanced industries and industry segments rather than its ability to exploit comparative advantage of inherited endowments of factors of production.

The industries that support a high and rising standard of living today are knowledge intensive. As the global economy has become more integrated, possessing cheap land, labour, or even capital has become less of an advantage. Success in international trade has become more a function of the ability to develop and deploy technology and skills than of proximity to low-cost inputs. Innovation in the broadest sense of the term, has become vital to success in international competition.

Manufacturing has been a driving force in the economic development of most countries since the industrial revolution. A strong, competitive manufacturing industry selling a multiplicity of goods to many markets has become the hallmark of mature economies and important contributor to their prosperity. In the last half century Japan and Germany built their economic miracles largely on the growth of powerful manufacturing industry. More recently the new industrial countries of Asia, such as South Korea and Singapore, have accorded high priority to attracting investment in industry as a key element in their spectacularly successful drive to achieve growth and prosperity.

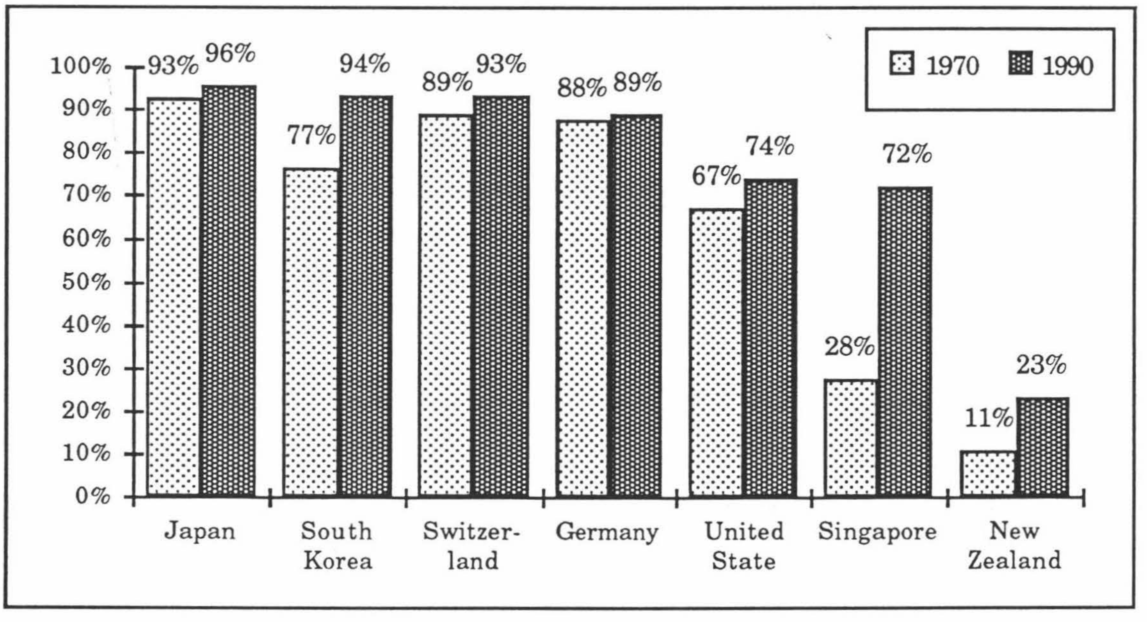
Table 2.1 and Figure 2.2 provide a picture of the position of manufactured goods (chemical products, other manufactured goods and machinery equipment) in the global trade. For the high-income countries such as Japan, Germany, and Switzerland, in excess of 80% of their exports are manufactured. Singapore, as a newly industrial country, has increased its export of manufacturing goods from 27.6% (1970) to 71.7% (1990). The export of manufacturing goods in South Korea has reached to 93.5% (1990). Both Singapore and South Korea achieved a significant growth in total export values from 1970 to 1990 due to the contribution of the manufacturing.

It should be noted that the export of New Zealand's manufactured goods increased from 11% in 1970 to 23% in 1990[4], but the percentage of total export value of manufactured goods is still a relatively low compared with other industrial countries. There is a long way to go for New Zealand's manufacturing industry to improve its competitiveness in the global market in order to increase its percentage of total export values of manufactured goods, and the potential for globally driven manufacturing to play a larger role in New Zealand's economic development is becoming increasingly apparent.

	Total Export Values (m Dollar)		Growth Rate
	1970	1990	1970 / 1990
Germany	34,189	397,912	10.64
United States	42,590	371,466	7.72
Japan	19,319	286,768	13.84
South Korea	830	64,837	77.12
Switzerland	5,120	63,699	11.44
Singapore	1,554	63,699	39.99
New Zealand	1,203	9,045	6.52

Source: Handbook of international trade and development statistics, United Nations,1992

Table 2.1 Total Export Values (m Dollar) and Growth Rate (1970/1990)



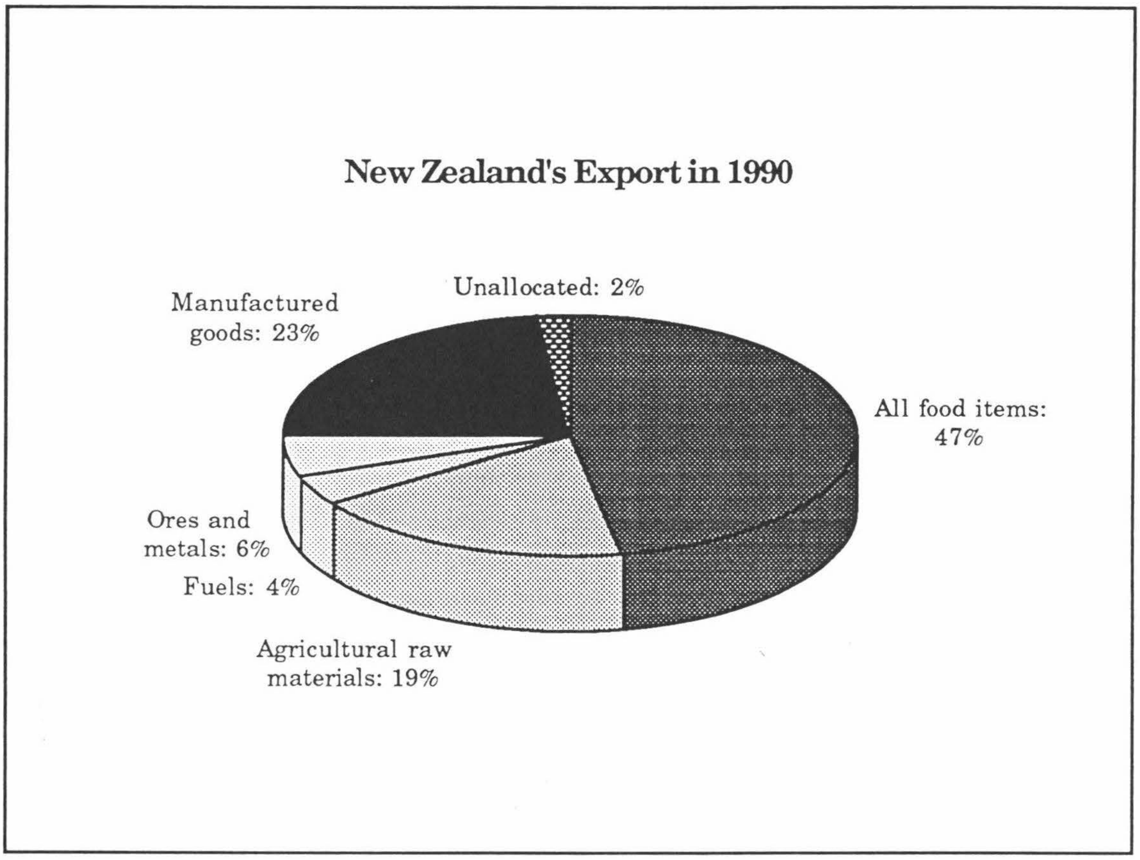
Note: Manufactured goods include chemical products, other manufactured goods and machinery and equipment.

Source: Handbook of international trade and development statistics, United Nations,1992

Figure 2.2 Export of Manufactured Goods As Percentage (%) of Total Export Values

2.3 New Zealand's competitiveness in global market

The structure of export sector provides a window into the strengths and weakness of New Zealand's entire economy and also to its competitiveness in global market. New Zealand's long-term adjustment to the new global economic order has been poor. As shown in Figure 2.3, the exports are still predominately resource-based commodities.



Source: Handbook of international trade and development statistics, United Nations,1992

Figure 2.3 The Structure of New Zealand's Export in 1990

New Zealand's export is structurally unattractive, and therefore a low profit, industry[5]. As a result, New Zealand producers are usually price takers rather than price makers for exports as well as for imports of machinery, industrial inputs, services and capital. This basic structural feature of many of the industries makes for an unfavourable long-term profit outlook. As Crocombe (1991)[5] said, these industries will be hard pressed to generate the high and increasing levels of income necessary for New Zealand to repay its debts and dramatically improve its standard of living relative to other advanced countries.

2.4 The position of manufacturing in the New Zealand's economy

The importance of technology and innovation can also be demonstrated by the analysis of the position of manufacturing in the New Zealand's economy.

2.4.1 Definition of manufacturing

According to the definition by the New Zealand Scientific and Industrial Classification (NZSIC), the major groups and some divisions (manufacturing divisions) are listed in Table 2.1:

Group 1:	Agriculture, hunting, forestry and fishing
Group 2:	Mining and quarrying
Group 3:	Manufacturing
Division 31:	Food, beverage, tobacco
Division 32:	Textile, apparel and leather goods
Division 33:	Wood processing and wood product manufacture
Division 34:	Manufacturing of paper and paper products; printing and publishing
Division 35:	Manufacture of chemicals and of chemical, petroleum, coal, rubber and plastic products
Division 36:	Concrete, clay, glass, plaster, masonry, asbestos and related mineral product manufacture
Division 37:	Basic metal industries
Division 38:	Manufacture of fabricated metal products, machinery and equipment
Division 39:	Other manufacturing industries
Group 4:	Electricity, gas and water
Group 5:	Construction
Group 6:	Wholesale and retail trade and restaurants and hotels
Group 7:	Transport, storage and communication
Group 8:	Business and financial services
Group 9:	Community, social and personal services

Source: New Zealand Scientific and Industrial Classification, 1992

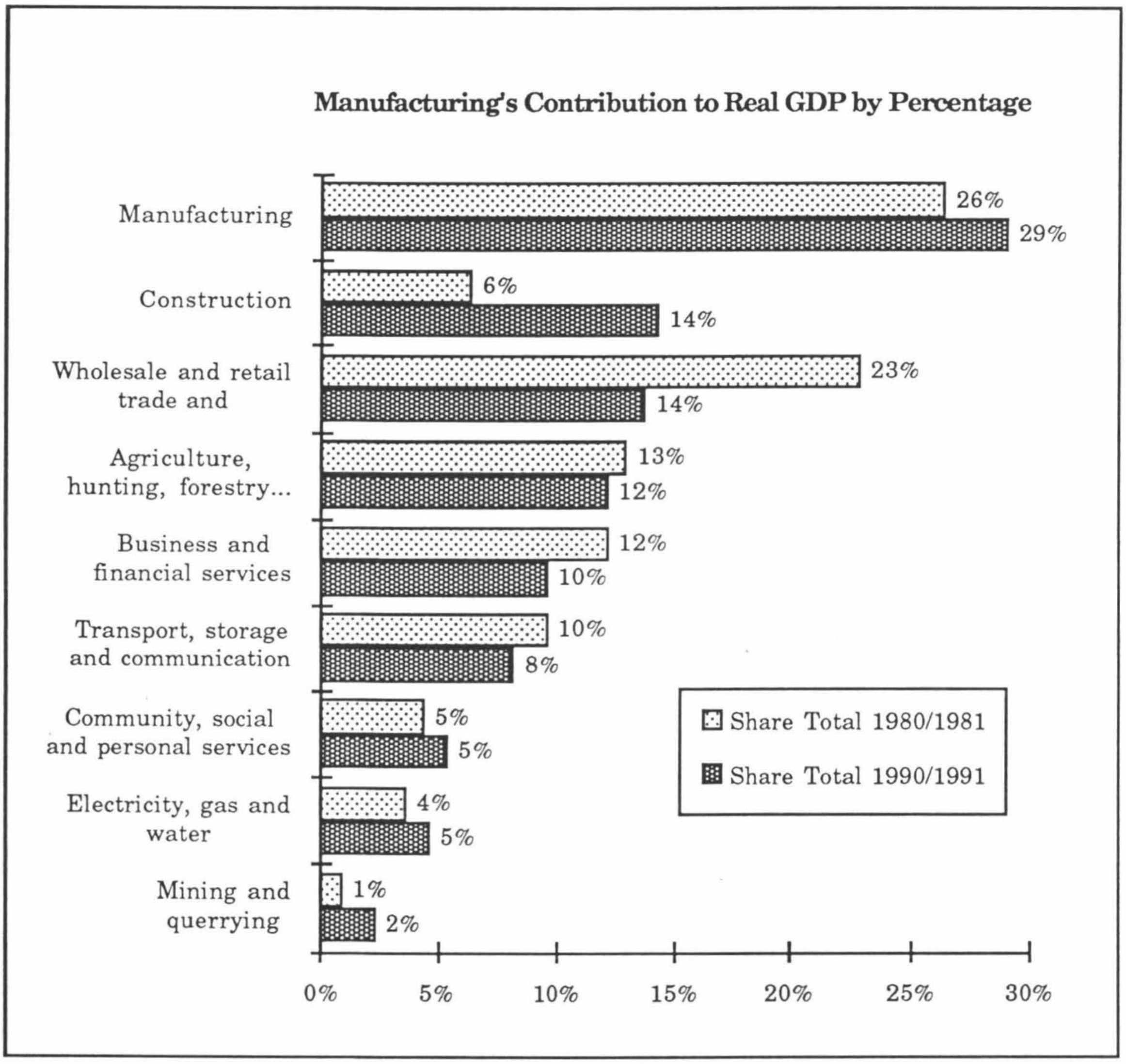
Table 2.2 Definition of New Zealand Industry Groups

Note:

In New Zealand, food and beverage, which makes a big contribution to GDP and employment, are included in manufacturing, other countries treat food and beverage outside manufacturing.

2.4.2 Contribution to real GDP and employment

The position of manufacturing in New Zealand's economy in relation to other groups can be briefly reviewed by its contribution to New Zealand's real GDP (Figure 2.4) and employment (Figure 2.5). It should be remembered, as stated previously, that manufacturing includes food and beverage in the following figures.

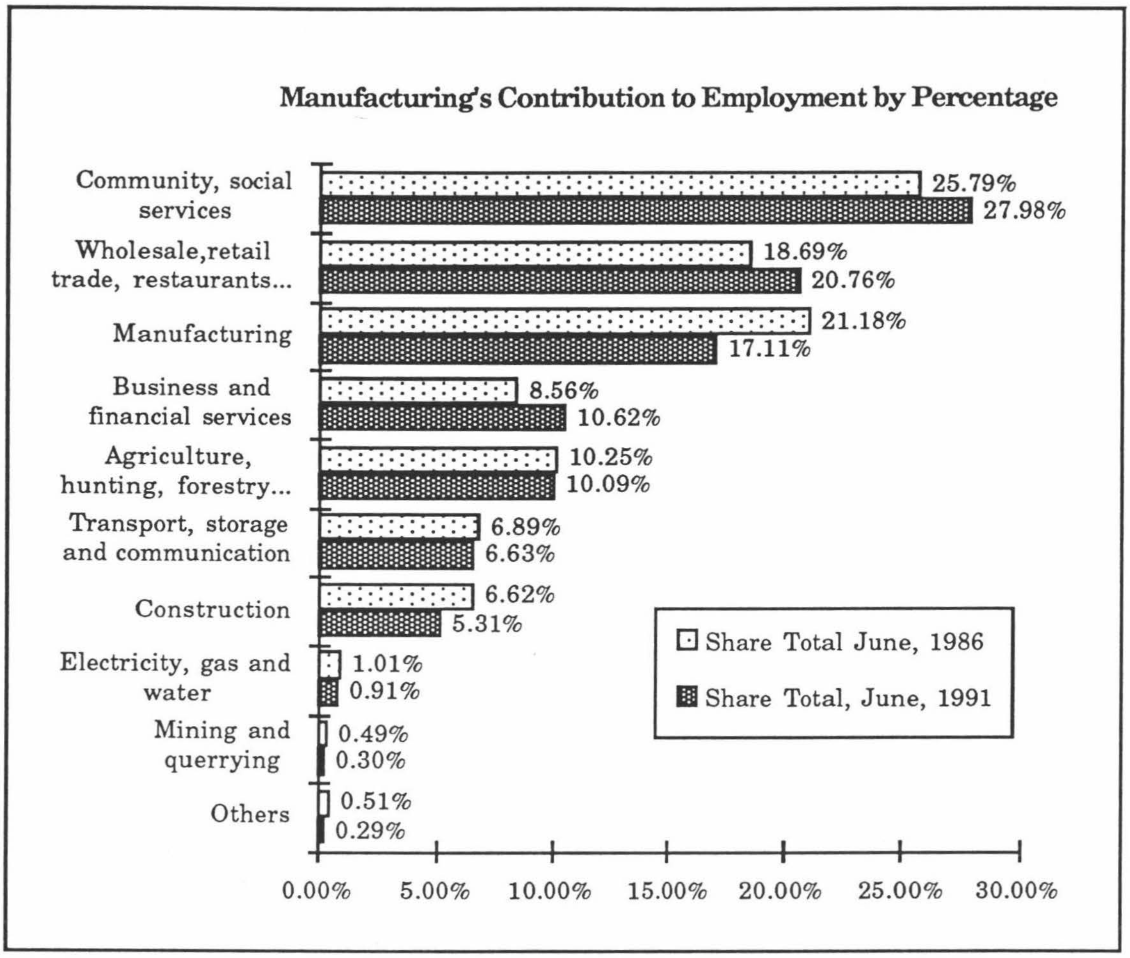


Source: PCINFOS, Massey Computer Network, 1993

Figure 2.4 Contributions to the NZ Real GDP by Percentage

Note:

The low growth GDP in manufacturing results largely from the effects of increased import competition and depressed domestic market conditions.



Source: PCINFOS, Massey Computer Network, 1993

Figure 2.5 Contributions to the NZ Employment by Percentage

Note:

The decline in employment in manufacturing stemmed from the same causes as GDP low growth and increased productivity.

The situation of manufacturing in the New Zealand's economy was recommended by Manufacturing Advisory Group[6] as:

Manufacturing has developed in two main phases. Over the period from 1960 to 1980 it expended strongly under the combined stimulus of import protection and a range of government incentives. The development of manufacturing was a major aspect of the full employment and economic diversification policies of successive governments.

During the 1980s, under the influence of changing approach to economic development internationally, import protection and *incentives were progressively reduced and major adjustment and refocusing occurred. This was a period of confused economic signals to manufacturing. The redevelopment of manufacturing was frustrated by the combined effects of financial sector deregulation after 1984 and the subsequent channelling of national resources into speculative investments, the increase in the exchange rate to high levels between 1985 and 1988, high level of inflation, a depressed domestic market, and the failure to deregulate other markets, especially labour, as fast as imports.*

Over the past four years the position has improved steadily as the benefits of economic reforms has become stronger and the new export-oriented strategies of manufacturers have begun to generate results. For a time this was masked by continuing retraction in parts of manufacturing as import protection continued to decline, but the extent of the new strength of manufacturing is evident from its increased competitiveness, rising confidence, and the resurgence in exports across a substantial part of the group in the past year.

2.5 Discussion

The world has changed, but New Zealand has not changed enough to keep pace, especially in manufacturing industries. Restoring prosperity demands that New Zealand industry upgrade and broaden its competitive advantages by giving more emphasis on the technology and innovation. This is a complex challenge that will require sustained and systemic change in education system, attitudes towards competition, and prevailing management philosophies. The key elements for New Zealand to increase its competitiveness are suggested by Professor Barnes[7]:

- Focus on becoming internationally competitive through innovation.
- Change its approach to industrial governance to empower its people to create internationally competitive industries based on high added value.

- Change its current focus on cost and simplistic measures of productivity towards markets, customer needs, quality and niche products based on innovation and high added value.

- Undertake a major retraining and education programme to lift the level of skills the work force from the medium and low skill areas the higher skills areas based on the new technologies.

- Improve the investment climate not by using measures of financial performance alone but by focusing on the total causes, social and political environment in which enterprises and government participate.

- Establish an environment in which innovation and technology transfer are successfully achieved to produce internationally competitive products and services.

Chapter 3
Manufacturing Strategy

3.0 Introduction

This chapter includes two sections as follows:

(1) Reviews the literature on principles of manufacturing strategy.

(2) Summarises the survey results of global manufacturing strategy which was done by Ferdows, Miller, Nakane and Vollman in 1989 and the survey results of New Zealand manufacturing future which was done by Corbett in 1991.

3.1 Literature of manufacturing strategy

In 1969, Skinner presented the seminar article "Manufacturing - Missing Link in Corporate Strategy" (1969)[1], which seriously turned the interest of strategists towards manufacturing. In later research in the area of manufacturing strategy it was assumed that a manufacturing strategy could be a part of the accepted hierarchy of strategies suggested by Hofer and Schender (1978)[2]. Until the mid-1980s, most research on manufacturing strategy was directed towards logical deductions based on case studies. This method of research accelerated the creation of new terms as new results emerged which resulted in criticism that the research did not materially add to the conceptual inventory[3]. The adoption of methods and themes from related disciplines such as business strategy research was suggested.

Michael Porter's work (1985)[4] on "competitive strategy" became one of the mostly discussed topics when many American automotive companies were facing severe competition from the Japanese. Buffa (1984)[5] showed how new manufacturing strategies must become a vital part of overall corporate strategy for competitiveness and recommends six specific strategies to accomplish this. Riggs (1983)[6] also focused on recommending management strategies to improve competitiveness, with particular emphasis on high-technology companies. More recent works of Quinn (1985)[7], Waterman, Jr. (1987)[8], and Peters (1987)[9] emphasized the growing concern of competitiveness and the need for revolutionary management thinking to cope with unusual times of complexity and uncertainty in various areas of management activities, including technological innovation.

3.2 The definition of manufacturing strategy

The definition of manufacturing strategy was offered by Schroeder (1991)[10] as:

> *Manufacturing strategy provides a vision for the manufacturing organization based on the business strategy. It consists of objectives, strategies and programs which help the business gain, or maintain, a competitive advantage.*

Two things in this definition should be highlighted. First, a manufacturing strategy should provide a vision for where the organization is headed. Second, the manufacturing strategy should contain long-range objectives, as well as, strategy and programs for manufacturing. Therefore, manufacturing strategy must be linked closely with the business strategy and other functional strategies.

A useful characterization of types of strategy was used in Wheelwright (1987)[11]. This defines three levels of strategy as follows:

- *Corporate strategy*:
  It concerns with fundamental questions such as "what business are you in?" and with the acquiring and allocating of resources. This may include a corporate view of the development of technological resources.

- *Business strategy*:
  It is the level addressed by Porter's (1985) ideas of competitive strategy - "how does a company actually compete in a chosen segment of a market".

- *Functional strategy*:
  It deals with how separate functions (for example, manufacturing strategy) support the business in meeting its objectives.

3.3 Benefits of manufacturing strategy

There are four main reasons for wanting to develop a global manufacturing strategy:

(1) There is a deliberate focus and emphasis on competitive effectiveness worldwide.

(2) The strategy coordinates the worldwide manufacturing effort and thus eliminates or reduces the problems of a fragmented manufacturing network and the dissipation of resources on local improvements which may be marginal when viewed from a global perspective.

(3) It reinforces the interdependence between the business functions particularly between manufacturing, marketing and logistics.

(4) It further defines the character or reason for existence for each manufacturing operation which in turn provides the backdrop against which major decisions can be placed.

Some of the benefits of manufacturing strategy are as follows:

- Provides a long-run view of manufacturing.

- Helps to cope with a changing environment.

- Puts manufacturing in a proactive mode.

- Guides tactical decision making in manufacturing.

- Enhances communications with other functions.

- Helps the business compete successfully.

The first, and most important, reason for manufacturing strategy is to help the business compete. Strategy is externally oriented and can help manufacturing gain a competitive position or maintain its current lead. Manufacturing strategy is also intended to guide the day-to-day tactical decision making which goes on in manufacturing. Tactical decisions can be put into a strategic context and an overall policy framework. As such strategy helps set priorities among daily activities by establishing long-range objectives and plans. This should result in a better utilization of manufacturing resources.

Whenever the environment of the business is changing, manufacturing strategy becomes all the more important. In these cases, staying with the present strategy and technology can be disastrous as external environment world changes. Strategy in manufacturing is intended to identify the external environment and adapt to it in a strategic sense.

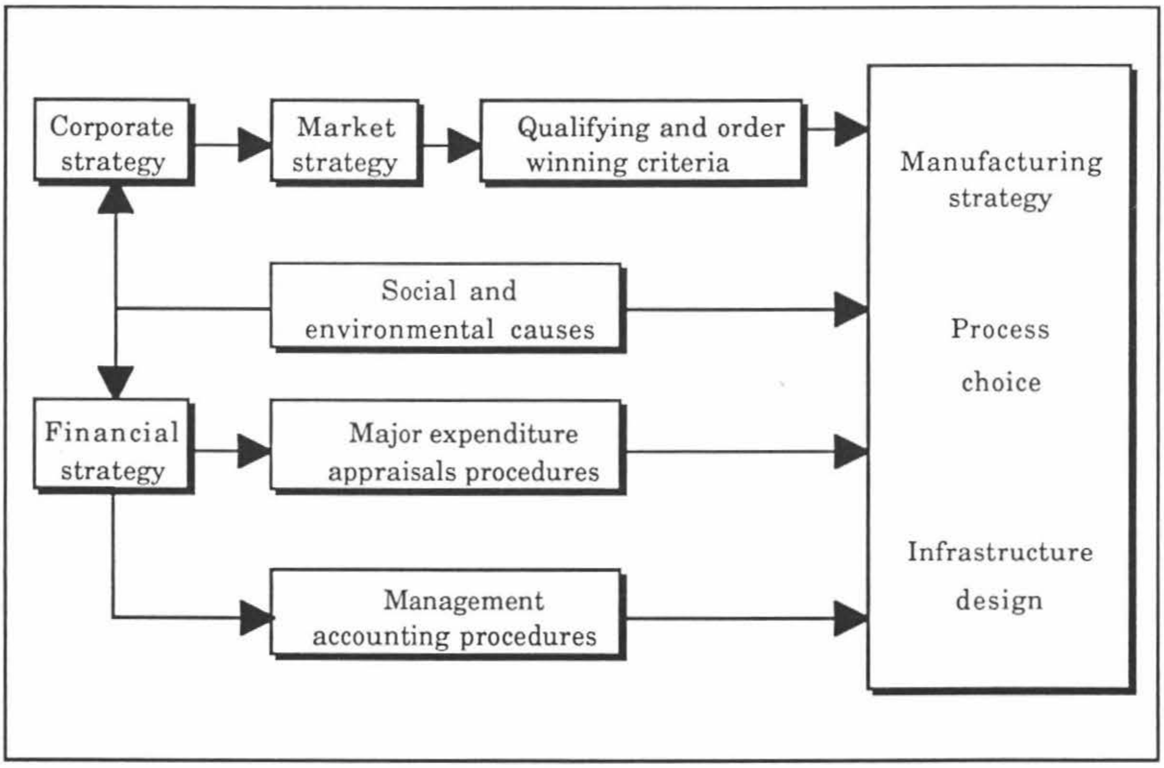
The strategy provides the opportunity to break down the conventions and to think about what the future holds, and to determine what manufacturing must do to help the business gain a competitive advantage.

By using a broad strategic planning process which involves other functions in the company, manufacturing can significantly improve its communications with other functions. The planning process will help others understand where manufacturing is headed and why certain objectives and strategies are being pursued.

Finally, the strategy casts manufacturing in a proactive role. With the strategy, manufacturing can get out in front and determine its own destiny. It can also explain more clearly why certain things can't be done, because they do not fit with the manufacturing strategy.

3.4 Formulation of a manufacturing strategy

As Hill[12] presented in Figure 3.1. , a strategy makes explicit a set of choices, each of which involves trade-offs between alternative costs and benefits. It is often simplistically stated that manufacturing's role is to provide the customer with the right product at the required quality, at the right time, and at the right price. Whilst obviously these are necessary conditions for success they are not sufficient conditions; the organization must also be profitable in a competitive set of markets. Thus a series of decisions must be made which have repercussions over differing time horizons. It begins with a consideration of corporate and market strategies but is then concerned with finding appropriate links between these and manufacturing choices.



Source: Hill, T ,"Manufacturing Strategy", Macmillan, London, 1985.

Figure 3.1 Manufacturing Strategy

Note:

Social and environmental causes are added into Hill's original diagram because the strategy must also consider social and environmental conditions.

The following list expresses some main criteria for the formulation of a manufacturing strategy:

- Price – including all extra costs and benefits such as financing arrangement.

- Product features — quality as represented by the specification of the properties of the product and service.

- Quality – as demonstrated by the way in which actual products conform to specification and requirements, indeed as they are fit for use.

- Product reliability – products conform to meet the condition need in operation.

- Design flexibility — tailoring of the product to meet specific customer requirements.

- Delivery lead-time — delivery dates quoted.

- Delivery performance — the reliability with which quoted delivery dates are met.

- Volume flexibility — the ability to supply the product in the volumes required by customers without compromising delivery lead-times or performance.

- Quotation performance — speed with which quotations are produced, in fact the general effectiveness with which a supplier reacts from the first moment of an approach by a customer.

- Service — professionalism of the delivery of the total service package, with particular emphasis on consultancy and customer training components.

- After-sales support — servicing effectiveness.

- Stability of the supplier — be able to continue providing support and develop new, compatible products (particularly important for suppliers of computing hardware and software).

3.5 Survey results of global manufacturing strategy

A particularly valuable source of projection of future manufacturing strategy is the "Manufacturing Futures Surveys" as reported in Ferdows, Miller, Nakane and Vollmann (1989)[13]. This involves surveys of 1,500 large manufacturers in Western Europe, North America and Japan in 1983, 1984 and 1985. The 1985 survey results are presented in Table 3.1.

Ranking	Europe	North America	Japan
1	Manufacturing to quality standards	Manufacturing to quality standards	Manufacturing to quality standards
2	Overhead cost	Overhead cost	Yield, rejects
3	Material cost	New product introduction	New product introduction
4	New product introduction	Sale forecasts	Process technology
5	Sale forecasts	Yield, rejects	Qualified supervisors
6	Indirect labour productivity	Vendor quality	Aging workforce
7	Inventories	Production lead time	Too many engin- -eering change
8	Delivery on time	Indirect labour productivity	Product line breath
9	Production lead time	Inventories	Delivery on time
10	Yield, rejects	Material cost	Direct labour
11	Aging plant and equipment	Delivery on time	Indirect labour productivity
12	Qualified supervisors	Process technology	Overhead cost
13	Government regulation	Vendor lead time	Inventories

Source : Ferdows, etc. (1989)[13].

Table 3.1 Concern: 13 Highest Rated Among 32 Choices (1985 Survey)

To concentrate only on the 1985 survey, the most highly rated concern in all three regions was manufacturing to quality standards, followed by issues which the chosen geographical region, except for a common concern for new product introduction. Ageing plant and equipment ranked only eleventh as a European concern, and process technology came twelfth in North America compared with fourth in Japan. Cost and productivity issues were given higher a ranking in the West compared with Japan (see Table 3.1).

More concrete are the action plans which companies have for the future (see Table 3.2).

R.	Europe	North America	Japan
1	Direct labour motivation	Direct labour motivation	Flexible manufacturing system
2	Production and inventory control system	Developing new processes for new products	Automating jobs
3	Automating jobs	Vendor quality	Developing new processes for new products
4	Integrating manufacturing information systems	Production and inventory control system	Production and inventory control system
5	Vendor quality	Statistical process control	Quality circles
6	Supervisor training	Integrating manufacturing information systems	Integrating manufacturing information systems
7	Integrating information systems across functions	Zero defects	Vendor quality
8	Developing new processes for new products	Developing a manufacturing strategy	Worker safety
9	Reducing the size of the workforce	Integrating information systems across functions	Value analysis
10	Manufacturing reorganisation	Statistical product quality control	Reducing lead time
Note: R. = Ranking			

Source : Ferdows, etc. (1989) [13].

Table 3.2 Ten Most Important Action Plans (1985 Survey)

In Europe the consistently highly rated plan was reported as "direct labour motivation" followed by a variety of plans including, as in America, an intention to develop integrated manufacturing information systems.

This shows a concern for the improvement of the manufacturing infrastructure.

In Japan the top 1985 action plans were developing Flexible Manufacturing Systems (FMS). The production and inventory control systems for which Japan is famous moved to fourth place. The authors of the report speculate that Japanese companies pursue a consistent strategy starting with the achievement of high quality, followed by delivery reliability, the reduction of production cost and finally the increase of production flexibility. On this evidence, Japanese companies, while maintaining a concern for quality standards, are in the later stages of this strategy. Progress in the years since 1985 has shown the strength of this strategy. Compared with Europe and North America companies, "labour motivation" was not seen as a problem by the Japanese companies. It should be noted that one of the methods for Japanese companies to approach "labour motivation" is based on the Japanese style management which emphasises on strong bond between the employing organization and the individual worker. This involves shared loyalties – loyalty of the organization to the needs of the individual employee, and loyalty of the individual to the objectives of the organization.

It should be also noted that Europe, unlike North America and Japan, didn't ranked the "developing new processes for new products" as important action plan. That may be the reason why the innovation companies mostly appeared in American and Japanese companies.

3.6 Survey of New Zealand manufacturing future

3.6.1 Competitive manufacturing ability

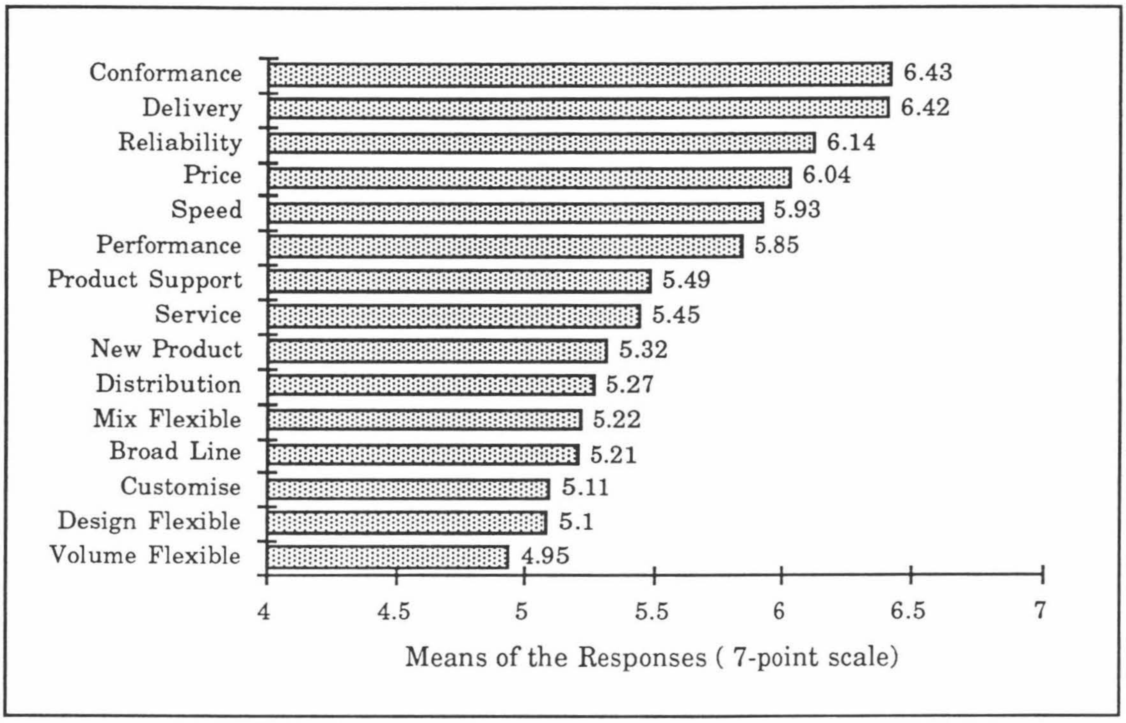
The survey by Corbett (1991)[14] refers specifically to New Zealand manufacturing operations and covers 600 largest manufacturers (in terms of number of employees). In seeking to build a manufacturing strategy that will provide a competitive advantage, the respondents were asked to indicate on a "7-point Likert" scale the relative importance of 15 specific capabilities for competing in the marketplace over the next 5 years. The ranking of the means of the responses is shown in Table 3.3 and graphically presented in Figure 3.2.

Ranking	Competitive Ability		Mean
1	Conformance:	To offer consistently low defect rates	6.43
2	Delivery:	To make dependable delivery promises	6.42
3	Reliability:	To provide reliable durable products	6.14
4	Price:	To profit in price competitive markets	6.04
5	Speed:	To provide fast deliveries	5.93
6	Performance:	To provide high performance products or product amenities	5.83
7	Product Support:	To provide product support effectively	5.49
8	Service:	To provide effective after sales service	5.45
9	New Product:	To introduce new products quickly	5.32
10	Distribution:	To make product easily available	5.27
11	Mix Flexible:	To make rapid product mix changes	5.22
12	Broad Line:	To offer a broad product line	5.21
13	Customise:	To customise products and services	5.11
14	Design Flexible:	To make rapid changes in design	5.1
15	Volume Flexible:	To make rapid volume changes	4.95
Note: 1 = very unimportant, 7 = very important			

Source: Corbett, L., "1990 New Zealand Manufacturing Futures Survey", 1991

Table 3.3 Relative Importance of Competitive Abilities

The ability to offer consistent quality and dependable delivery is ahead of the ability to provide reliable and durable goods, to compete on price, fast delivery, and the ability to offer high performance product.



Source: Corbett, L., "1990 New Zealand Manufacturing Futures Survey", 1991

Figure 3.2 Relative Importance of Competitive Abilities

3.6.2 The most useful programmes for manufacturing

In order to tap the conceptual domain of an intended manufacturing strategy as represented by the current set of action programmes, 26 questions on activities, tools or programs to improve the effectiveness of operations were presented to the respondents. The following table (Table 3.4) shows the percentage of respondents who had given significant emphasis to the key action programmes and activities in the past two years.

For those programmes emphasised by more than 50% of respondents there is a strong commitment to staff training throughout the organization. Also they show a strong push to change attitudes and practices in manufacturing. Quality function deployment, for example, is concerned with translating customer needs into product and design specifications and manufacturing methods. It therefore involves a cultural change throughout the organization to focus more on quality.

Key action programmes and activities	% of respondents
Supervisor training	70
Worker training	65
Workers more tasks/responsibility	60
Manufacturing reorganization	58
Management training	56
Quality function development	54
Integrating manufacturing information systems	53
Developing new processes for old products	49
Linking manufacturing strategy to business strategy	49
Reconditioning physical plants	48
Improving inventory control systems	47
Integrating information systems across functions	43
Just-in-time	43
Developing new processes for new products	42
Hiring new skills from outside	40
Active-based costing	39
Statistical quality control	39
Quality circles	33
CAM	32
Flexible manufacturing systems	32
Interfunctional work teams	32
Closing/relocating plants	29
Value analysis/product redesign	28
CAD	27
Design for manufacture	25
Robots	7

Source: Corbett, L., "1990 New Zealand Manufacturing Futures Survey", 1991

Table 3.4 Degree of Emphasis on Action Plans Over Next Two Years

3.7 Summary

After reviewing the principle of manufacturing strategy, and the comparison of manufacturing strategy between the industrial countries (Europe, North America and Japan) and New Zealand, the following issues can be summarized as:

- Improving competitiveness depends on linking manufacturing strategy to business strategy, and quality function is one of the critical factors in manufacturing strategy.
- New Zealand's manufacturing industry have the same attitudes and concerns as other industrial countries about the "product conformance".
- New product introduction has become an important factor in competitive ability, but New Zealand manufacturing companies didn't ranked it as critical factor. More effort is required to improve innovation activities .
- For the New Zealand manufacturing industry, delivery reliability was given more concern than other industrial countries.
- People skills training was regarded as one of the most urgent needs for New Zealand manufacturing industry to improve its productivity and competitiveness.

Chapter 4
World Class Manufacturing

4.0 Introduction

Manufacturing is a complex activity drawing upon many disciplines and technologies, reflecting management attitudes and philosophies, dependent upon organizational structures, influenced by the customers for products and the suppliers of the many materials, machines, and equipment used to produce those products.

In order to understand world class manufacturing, this chapter focuses on manufacturing systems which include current manufacturing technology and management system.

4.1 Brief review of the changes in manufacturing technology

In terms of managing manufacturing, the first major advantage after 1945 was the advent of computer and information technology generally as well as the introduction of numerically based manufacturing management techniques such as materials requirement planning (MRP) in the sixties. From about this time a number of computer systems relevant to the management of manufacturing became commercially available but the systems did not fully integrate the various elements of production, let alone the other functions of the business. In general, the problem resulting from traditional production planning and control systems continued.

Since 1980, however, several new approaches to managing manufacturing were available including:

- Computer Integrated Manufacturing (CIM)
- Manufacturing Resources Planning (MRPII)
- Optimised Production Technology (OPT)
- Just-in-Time (JIT)
- Total Quality Management (TQM)
- Innovation and Technology Management

In the late 1980's the approach to managing manufacturing was developed further with the introduction of other world class manufacturing management technologies such as rapid prototyping, concurrent engineering, fuzzy logic etc.

The concept of Computer Integrated Manufacturing (CIM) has arisen almost as a direct result of advances in the twin areas of manufacturing technology and information technology. The roots of CIM are to be found in the earlier concepts of computer aided manufacturing (CAM), computer aided design (CAD), computer aided engineering (CAE) and flexible manufacturing systems (FMS). At the present time CIM shows enormous potential from both a technical and managerial viewpoint.

MRPII essentially integrates the elements of production with other business functions to form a true management system and is heavily promoted and publicised by the American Production and Inventory Control Society (APICS).

The late seventies also saw the introduction of OPT, a proprietary computerised scheduling algorithm.

JIT is also an evolutionary product but its roots go back to post-war Japan and the approach the Japanese took to their manufacturing industry after studying some of the best examples in USA. However the concept, philosophy and operational aspects of JIT in its entirety were probably not completely visible to western industrial managers and academics until the mid 1970s with the best known example being the Toyota Motor Company.

Total quality management or TQM theory was developed by Deming, Juran , and Ishikawa. It can be seen as a business discipline and philosophy of management which focuses on customer satisfaction rather than price. "Quality" is much the same as "excellence" in recent management jargon, and the test of quality management is its ability to satisfy customers in market-place. Total quality management assumes that quality is the outcome of all activities that take place within an organization, that all function and all employees have to participate in the improvement process.

4.2 Some major manufacturing technologies

Some major manufacturing technologies such as CIM, MRPII, JIT, TQM and innovation management, which will be relevant to the analysis in the later chapters, are discussed in the following sections.

4.2.1 Computer integrated manufacturing (CIM)

Figure 4.1 presents a sample of the current trends in manufacturing technology in which computers are now being used to accomplish computer integrated manufacturing. This is manufacturing that uses a variety of computer applications to automate and integrate activities. It is also manufacturing that is well supported by appropriate information systems.

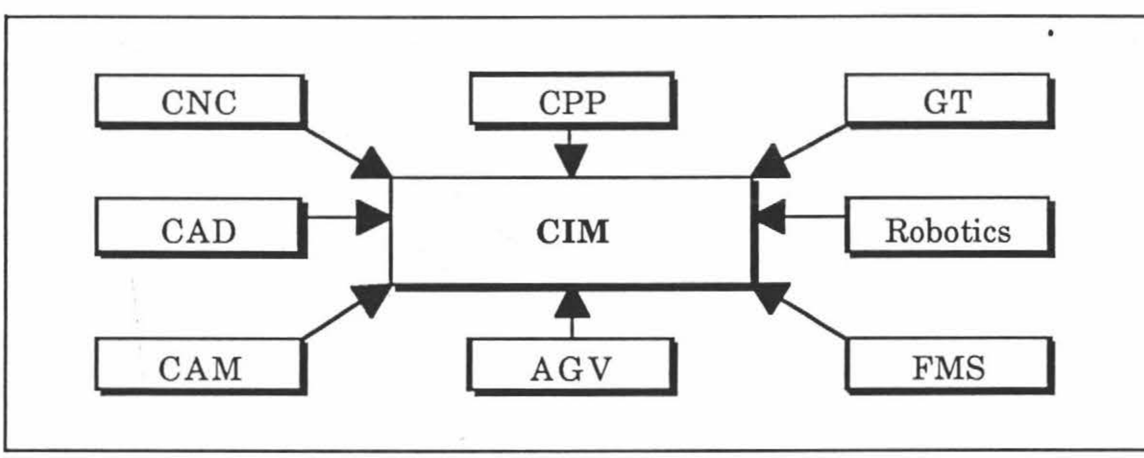


Figure 4.1 Computer Integrated Manufacturing (CIM)

The functions relevant to CIM are listed as:

- Computer Numerical Control (CNC)
- Computer-aided design (CAD)
- Computer-aided manufacturing (CAM)
- Computer-aided process planning (CPP)
- Automated guided vehicles (AGV)
- Group technology (GT)

- Robotics
- Flexible manufacturing system (FMS)

Computer integrated manufacturing includes the engineering functions of CAD/CAM and also the operational and information processing functions of the manufacturing unit as a whole. It is usually described as the culmination of a historical process leading from mechanisation (replacing human labour by machine such as AGV, Robotics, etc.) through point automation (individual CNC machines) and islands of automation (FMS) to the computer-based integration of a total manufacturing system.

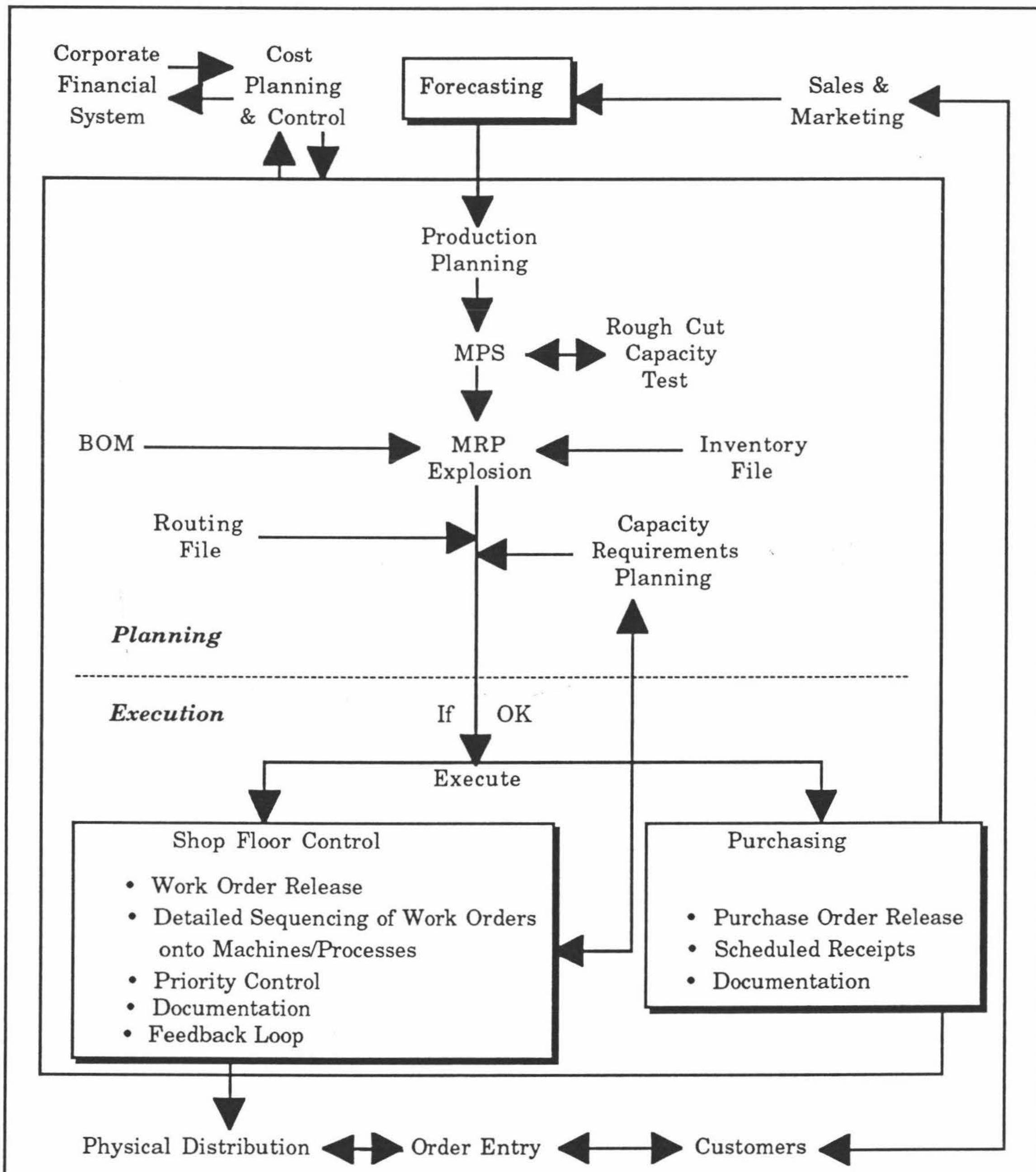
Computer integrated manufacturing (CIM) may also be viewed as a series of interrelated activities and operations involving design, material selection, planning, production, quality assurance, management and marketing of discrete products. It is the deliberate integration of automated systems into processes of producing a product and can be considered as the logical organisation of individual engineering and production and marketing support functions into a computer integrated system. CIM covers all activities related to the manufacturing business including product design, process planning, the evaluation and development of different product strategies, and so on. In broad terms the aims of CIM are:

(1) To improve product reliability.
(2) To make the total manufacturing process more productive and responsive.
(3) To reduce the total cost of manufacturing.
(4) To reduce the number of hazardous jobs.

It should be noted that FMS is an important function to achieve CIM. In an FMS a number of machine tools and items of handling and testing equipment are integrated by computer control to process simultaneously a variety of parts. The major advantage of this arrangement is that once a batch of items is within the system, a considerable amount of work is carried out on items in the batch with little time for machine set-ups and manual intervention. FMS has been regarded by Japanese companies as their first important action plan to achieve competitive capability (see Table 3.2 in Chapter 3)

4.2.2 Manufacturing resource planning (MRPII)

MRPII is above all a management system. It integrates the manufacturing management information systems with the normal business systems. A schematic of MRPII is shown in Figure 4.2. The modules within the box are those normally the ambit of manufacturing management. They are separated into those essentially concerned with planning and those involved in the execution of those plans.



Source: Greenhalgh, Manufacturing Strategy, 1991

Figure 4.2 MRPII Schematic

The interdependence between module activities and the integrated nature of the system results in synergy (that is, the effectiveness of the total is greater than the sum of the individual parts) and also stresses the impact of non-manufacturing function. In other words, MRPII recognises that the complete manufacturing process is made up of a series of interdependent elements and that a single element cannot be considered without considering the impact on the other elements. From a management viewpoint the significance of information and data processing technology is clear since by linking together and integrating all operations through a common database the effectiveness of the system is enhanced.

The following is a brief explanation of the modules shown in Figure 4.2.

- Master production schedule (MPS):
  MPS states how much and when finished products will be produced, over a future planning horizon.

- Bill of materials (BOM):
  BOM contains, for each finished product, details of all individual items needed to produce the product.

- Inventory File:
  For each item gives current quantity on hand.

- Materials requirements planning (MRP explosion):
  MRP explosion is the combination of the MPS, BOM and inventory file to produce time phased net requirements of individual items needed to produce finished products.

- Routing file:
  For each item in the BOM shows the sequence of operations required to produce it and the work centres involved.

- Capacity requirements planning (CRP):
  CRP checks to ensure that each work centre has capacity to achieve the desired plan.

4.2.3 Just-in-Time (JIT)

A schematic of JIT is shown in Figure 4.3. The two pillars of JIT are "respect for people" and "elimination of waste". An understanding of JIT is based on an understanding of these two deceptively simple phases. Only people solve problems, not technology, systems, rules or procedures. People identify the problem or opportunity and people decide the solution. Each employee, whether manager, supervisor, line operator or machine operator, has unique information about their job that few others, if any, have. JIT's power is derived from the translation of that unique information through people into problem/opportunity identification and solution.

Just-in-Time production also aims at the elimination of waste. The waste is found in the conventional approaches to quality, product development, purchasing, job assignments, plant configuration, equipment selection, maintenance, scheduling, accounting, material handling, material control and shop floor control. Anything which does not add value to the product is waste. The benefits of waste elimination cannot be overstated: in the broad sense waste elimination results in simplification and with simplification comes flexibility. Some of the results of the JIT approach are also shown in Figure 4.3 under the nominal headings of cost, quality, flexibility and dependability.

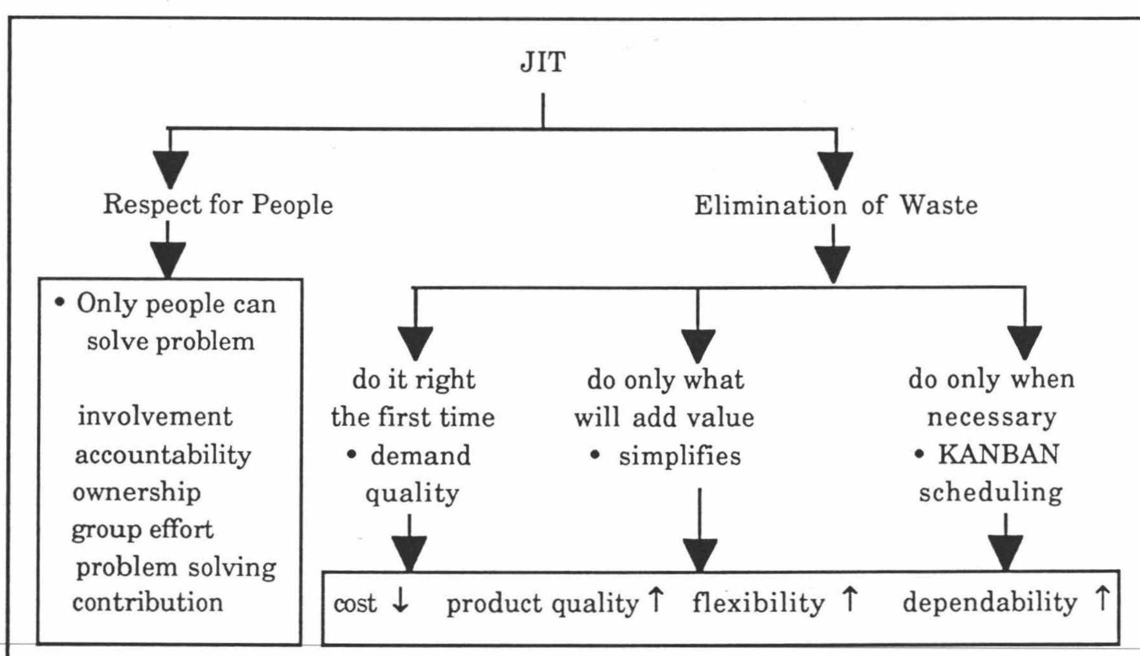
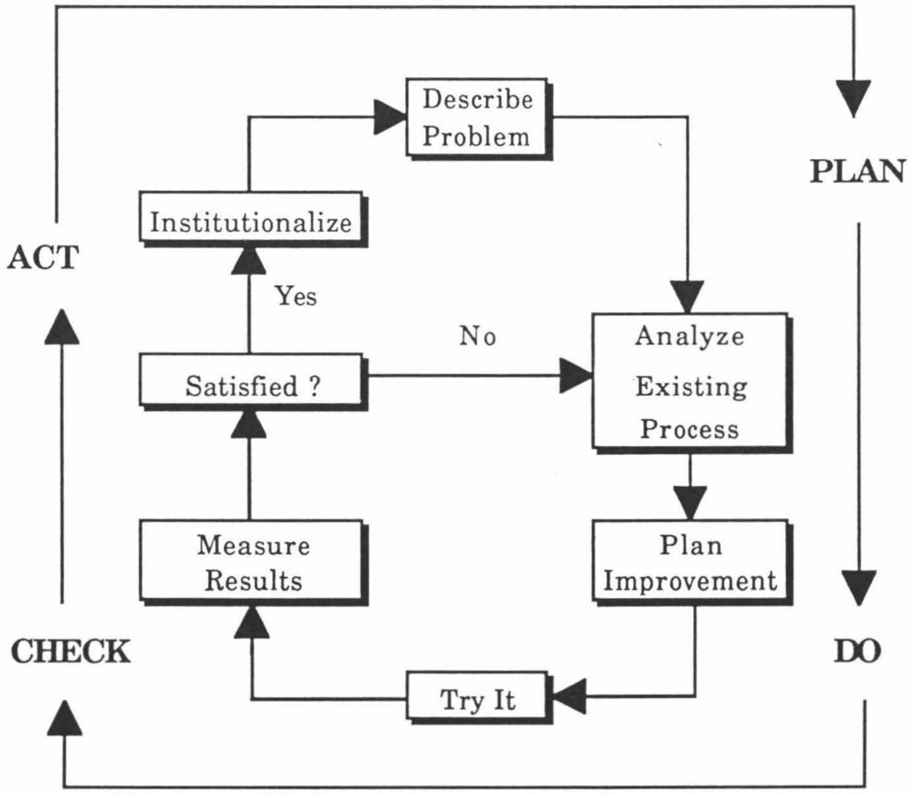


Figure 4.3 JIT Schematic

4.2.4 Total quality management (TQM)

Total quality management (TQM) is examined from an expanded viewpoint which goes beyond classical manufacturing-oriented measures. The key elements of the TQM process include a structured approach to improving processes, and a company-wide infrastructure for focusing on quality and customer satisfaction. Deming was an early exponent of TQM and SPC ideas which are based on continuous improvement through application of the scientific method and team work.

The first principle of TQM is that it is focused on improving processes and not blaming and punishing people. For many organizations this is an important but difficult cultural change. In order to improve processes a disciplined approach for process improvement is used. The improvement model which suggested by Deming is based on the Shewhart cycle of PLAN-DO-CHECK-ACT.



Source: Deming, Out of the Crisis, 1986.

Figure 4.4 TQM Improvement Model

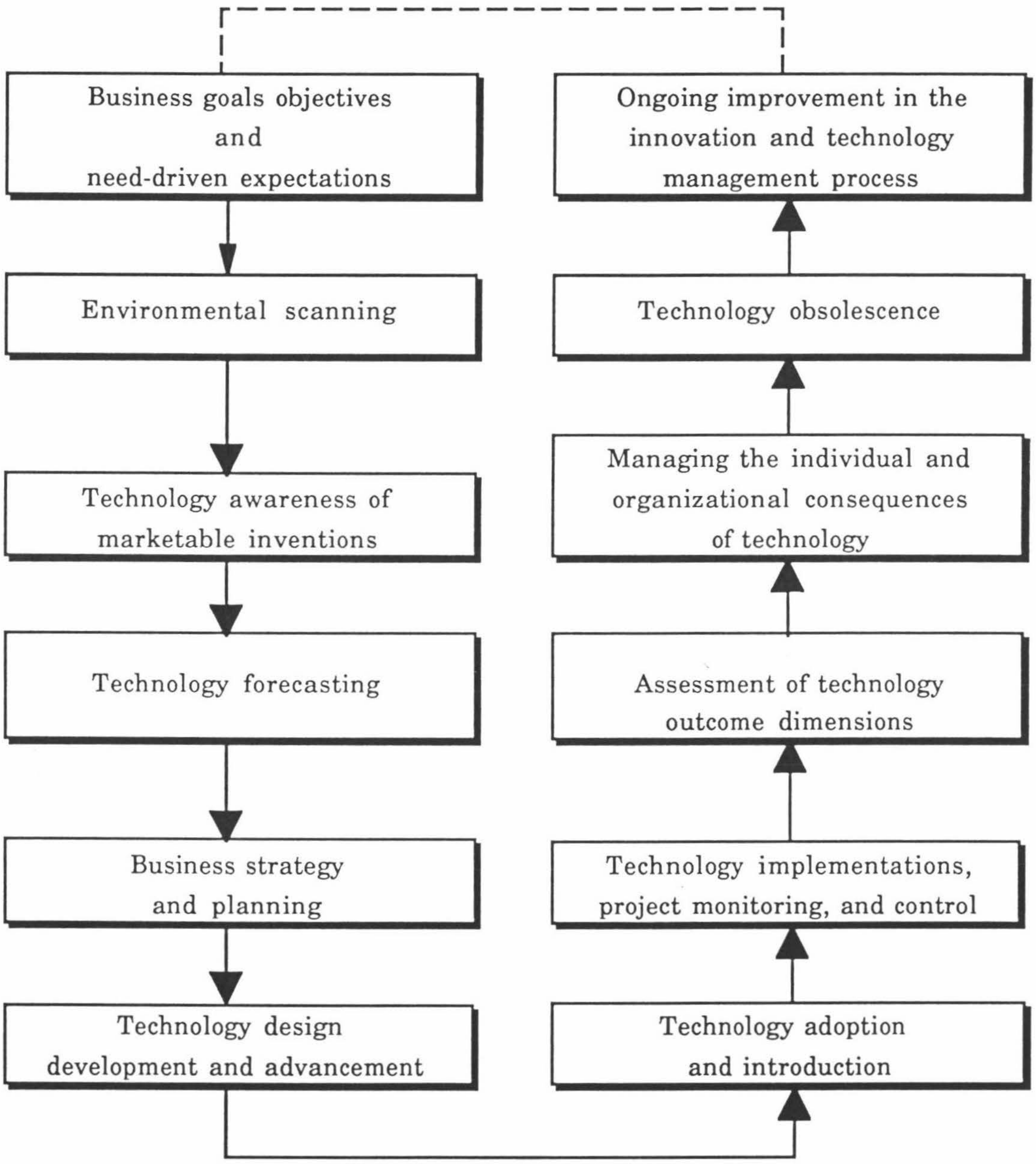
This cycle is based on scientific methods of planning a test of a hypothesis, carrying out an experiment to test the hypothesis, checking the results of the experiment against the expected results using data, and then acting on the results, either to do additional tests or change the hypothesis based on the results.

The improvement model (see Figure 4.4) is supported by a structured approach to problem solving. It begins by describing the problem as thoroughly as possible using the data which is available. The next step is to clearly identify and analyze the process which has the problem to identify the root cause of the problem. The root cause is that cause which when eliminated will prevent the problem from recurring. Once the root cause is identified a plan for eliminating or correcting the problem is developed. The plan is implemented and the results are measured using process data. The question, "satisfied?" is asked by the team. If the answer is no, they go back and re-analyze the process, applying the lessons learned and develop a new plan of action. In time, when they ask the question, "satisfied?", the answer will be yes and the last critical step will be taken to institutionalize the improvement. Institutionalizing means adopting procedures, checklists, process measurements, training and other steps that assure that the process will continue to perform in the improved manner over time.

Most of the processes which are dealt with are complicated and often difficult to work with. To help with the task of improving processes the improvement model is supplemented by the use of problem solving tools such as Flow Charts, Check Sheets, Pareto Charts, Cause and Effect Diagrams, Scatter Diagrams, Run Charts, Histograms and Control Charts and experimental design. Detailed descriptions and instructions about the application and use of these tools is readily available from a variety of sources.

4.2.5 Innovation and technology management

Innovation and technology management requires an integrated process involving both management and employees with the ultimate goal of managing the innovation, design, development, production, transfer, introduction, and use of the various forms of technology in the work environment. Figure 5.4 presents the steps of innovation and technology management process.



Source: Edosomwan, J.A., Integrating innovation and Technology Management

Figure 4.5 Innovation and Technology Management Process

Useful technologies and their effective management are achieved through the innovation and technology process if there are techniques and methodologies in place for comprehensive technological planning, forecasting, assessment, introduction, measurement, control, evaluation, implementation, improvement, and monitoring. An effective systems approach that involves both management and employees in bringing forth new innovations and technologies is recommended, as is the management of both positive and negative consequences of technology.

Chapter 5
Brief Review of Plastics Industry

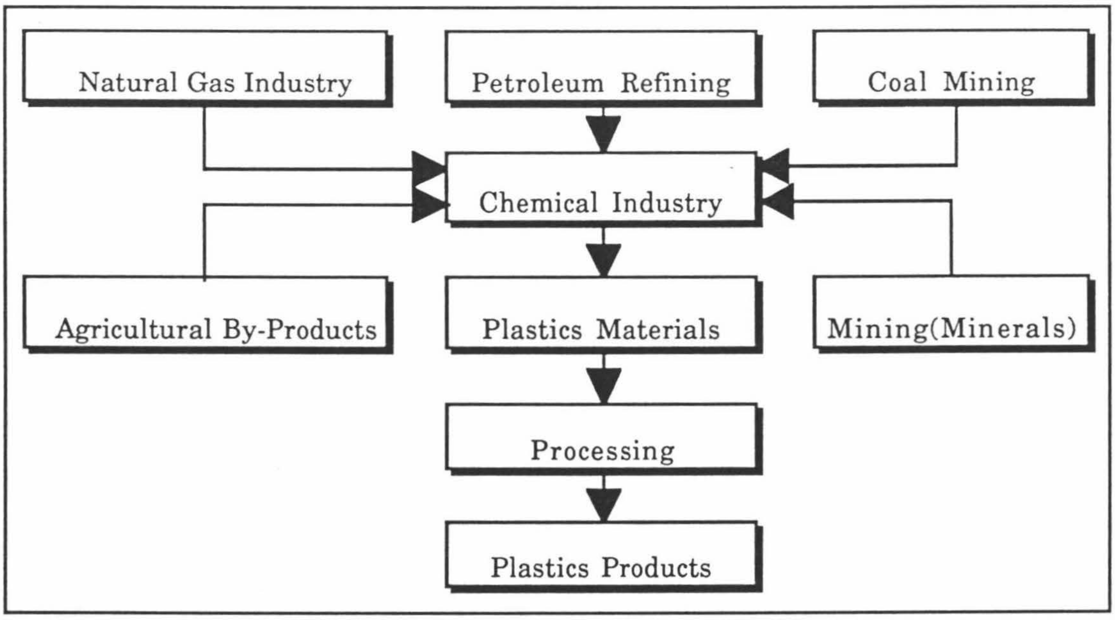
5.0 Introduction

Since the case study to be used for innovation and technology management is to be based on the plastics industry, this chapter briefly reviews what constitutes the plastics industry, its situation and condition in the global economy as well as its development trends.

5.1 Constitution of the plastics industry

- Relationship with other industries

The production relationship between the plastics industry and other industries is presented in Figure 5.1. Plastics is one of the major products in the chemical industry. Through specific chemical processes, plastic materials are obtained by combining some basic chemicals extracted from petroleum, natural gas, coal, air, water, and agricultural by-products.



Source: R. V. Milby, Plastics Technology.

Figure 5.1 Plastics Industry and Other Industries

- Constitution of plastics industry

The processing and application of plastics materials constitute the plastics industry (see Figure 5.2).

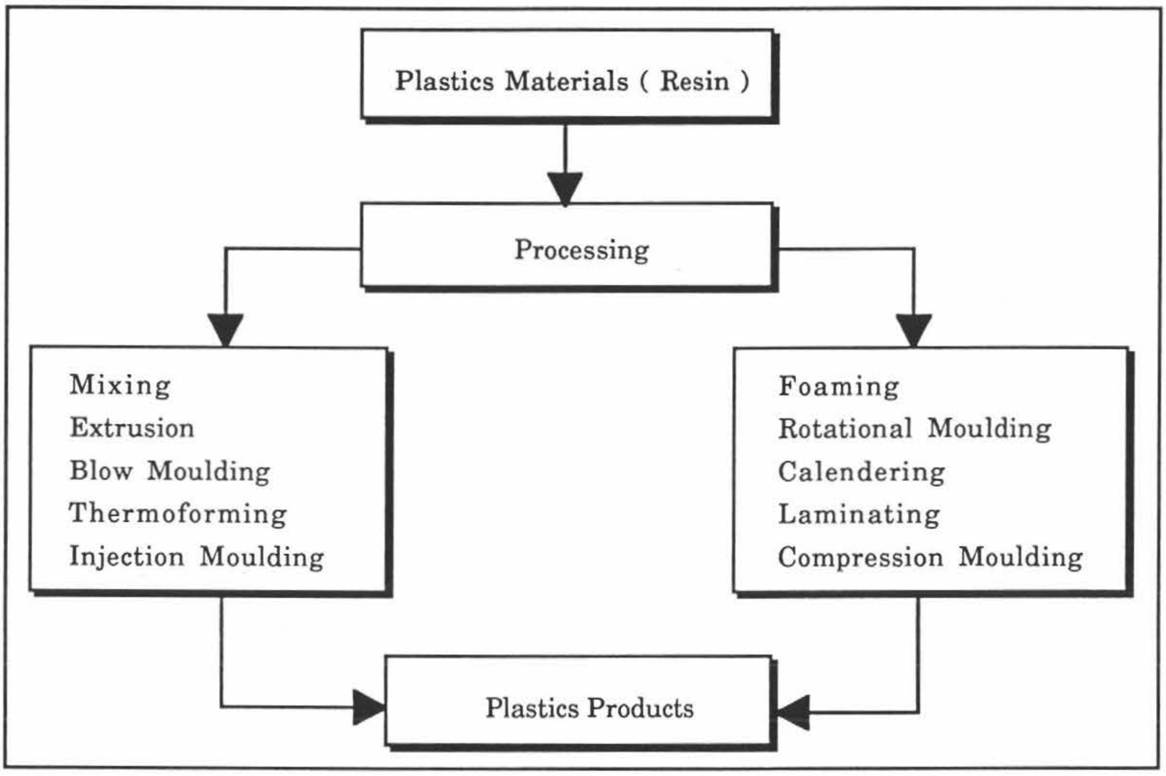


Figure 5.2 Constitution of Plastics Industry

Resin is the major plastics material, which includes a variety of polymers such as polyethylene, polypropylene, polyvinyl chloride, styrenics, polyester film (PET), acrylonitrile-butadiene-styrene (ABS), polyurethane, thermoset polyester and thermoplastics etc.

The major techniques related to plastics processing are described by Morton[1] as follows:

(1) Mixing

The polymer is mixed with other ingredients and additives and mixing processes may be used to alter its physical form.

(2) Extrusion

The extrusion process comprises the forcing of plastic or molten materials through a shaped die by means of pressure. In the modern process, screws are used to progress the polymer in the molten or rubbery state along the barrel of the machine. Two widely used types are single screw and twin screw extruder machine.

(3) Injection moulding

The basic principle of injection moulding is to inject molten polymer into a closed, cooled mould, where it solidifies to give the product.

(4) Blow moulding

The principle of blow moulding has been used for centuries by glass blowers. A semi-molten tube is formed; this is clamped between the two halves of a split mould and is inflated with air to fill the mould. The mould surfaces are cooled so that the product is frozen into shape whilst still under air pressure. The product is then recovered by opening the mould.

(5) Thermoforming

In thermoforming, a preform, usually an extruded sheet of polymer, is heated until soft and deformed by a shaping force into a cooled mould. Vacuum forming is the most widespread technique for thermoforming.

(6) Rotational moulding

Rotational moulding is the process to produce hollow shapes by rotating meltable, powdered polymers or fusible liquids in a heated, closed mould. Marine toilets, furniture, water tanks, and carrying cases are examples of rotational moulding.

(7) Laminating

Laminating is the process of combining layers of fabric, paper, or mat with thermoplastic or thermosetting resins.

(8) Calendering

Calendering is a rolling process to produce rigid or flexible thermoplastic sheets, and it is also the process used to apply films to substrates such as paper and cloth.

(9) Compression moulding

In compression moulding two dies are pushed together with heated platens of a hydraulic press to produce final products.

5.2 The situation and condition of plastics industry

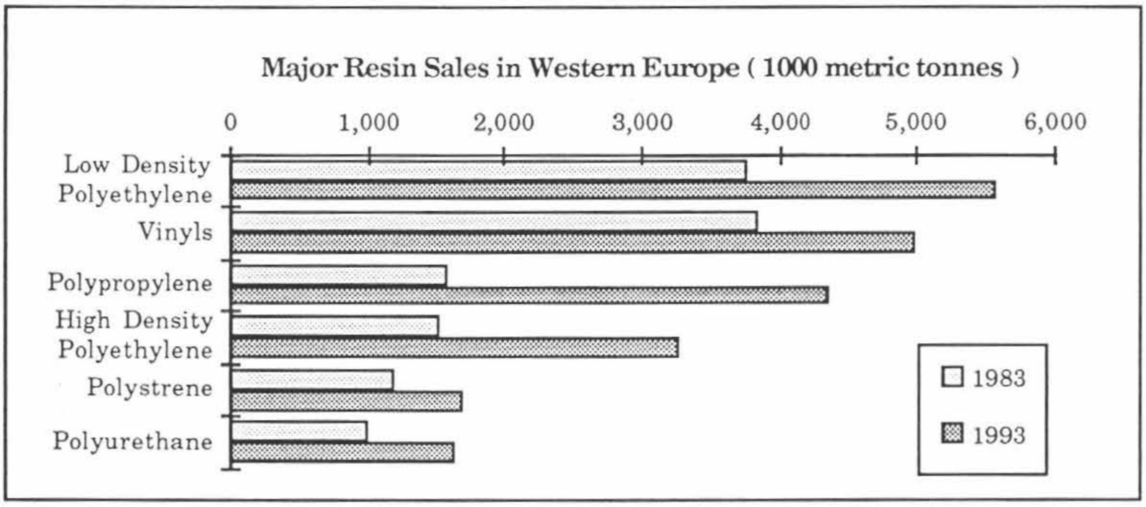
The situation and current growth trend of the plastics industry can be reviewed from the changes of resin sales and plastics machinery market.

5.2.1 Resin sales in the world

Resin is the major plastics processing material, its sales or consumption around the world is seen as one of the barometers of the general economic condition in the global plastics industry. The following figures provide a general information about the change of resin sales in Western Europe, Japan and United States. It can be found that resin sales reflected the general slowdown in the economy and accompanying downturns in capital investment in developed countries after 1990. The decrease in growth rate of resin consumption could also be caused by a combination of lower material usage, recycling, and less wastage arising from improved quality assurance in the manufacturing processes.

Source: Modern Plastics International, Jan. 1982 – Jan. 1994

Figure 5.3 Total Resin Sales in Western Europe 1983 – 1993



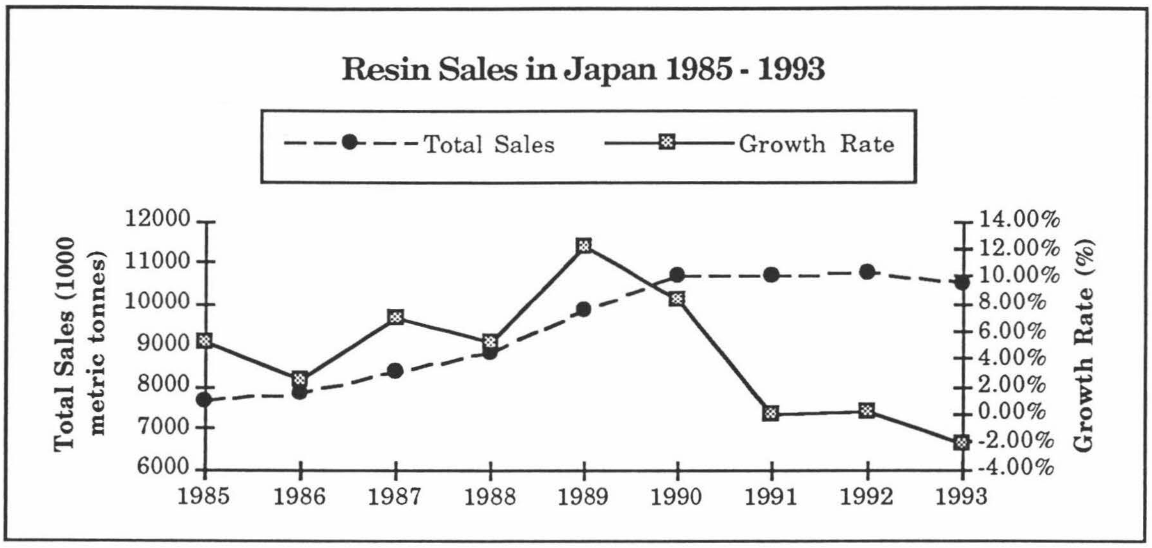
Source: Modern Plastics International, Jan. 1982 – Jan. 1994

Figure 5.4 Major Resin Sales in Western Europe in 1983 and 1993

Comments:

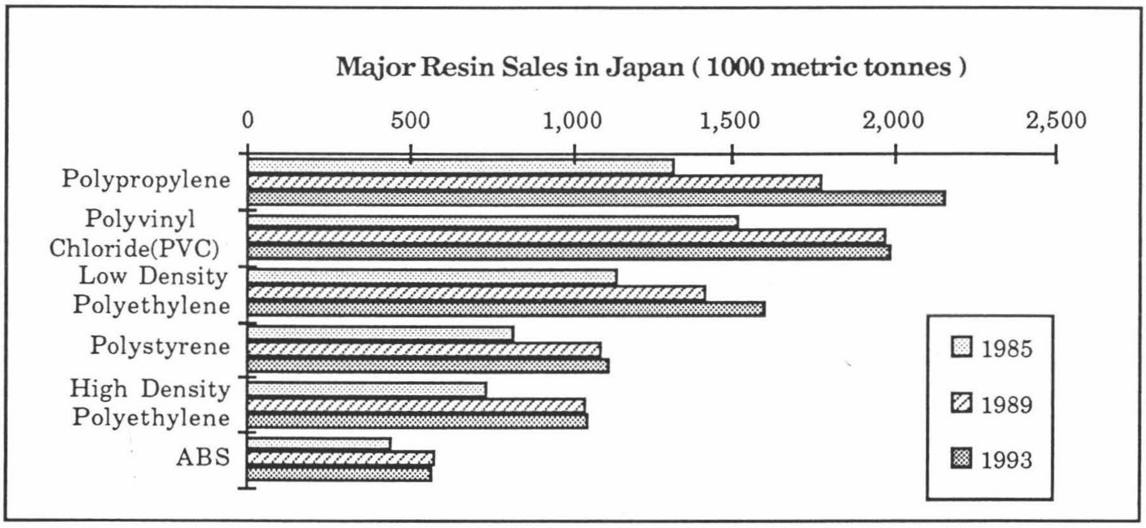
(1) The total resin sales in Western Europe maintained a healthy growth rate before 1986, but the growth rate has recently slowed down except for 1991 (see Figure 5.3).

(2) Low density polyethylene ranked in the top sale position in 1993. Polypropylene showed the fastest growth due to a rise in consumption of film/sheet and of injection moulding compounds (see Figure 5.4).



Source: Modern Plastics International, Jan. 1984 – Jan. 1994

Figure 5.5 Total Resin Sales in Japan 1985 – 1993

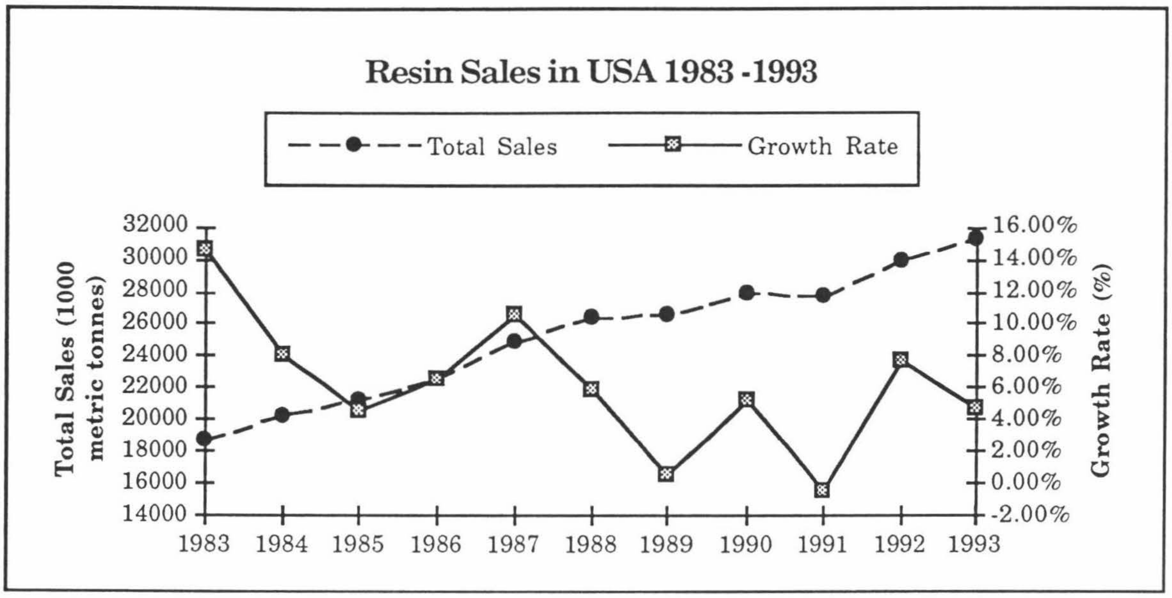


Source: Modern Plastics International, Jan. 1984 – Jan. 1994

Figure 5.6 Major Resin Sales in Japan, 1985,1989 and 1993

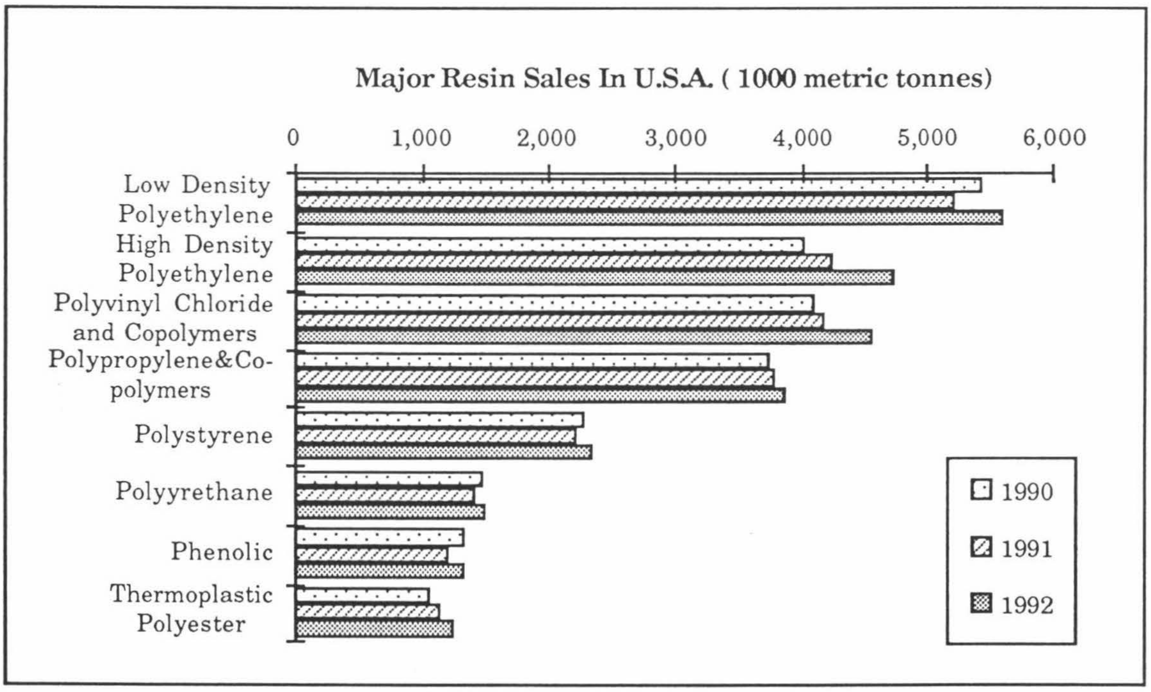
Comments:

The total resin sales in Japan (see Figure 5.5) increased quickly from 1986 to 1990 due to a boom economy, but after 1990 almost no growth was seen. Figure 5.6 shows low growth rates for major resins except polypropylene in 1993 compared with 1989. The reason behind this stagnation in plastics production was the general slowdown of the Japanese economy with the demand weak in automobile, construction, and electronics sectors. Another reason may be the movement of production from Japan into other countries, particularly the developing countries in Asia[2].



Source: Modern Plastics International, Jan. 1982 – Jan. 1994

Figure 5.7 Total Resin Sales in United States 1983 – 1993



Source: Modern Plastics International, Jan. 1982 – Jan. 1994

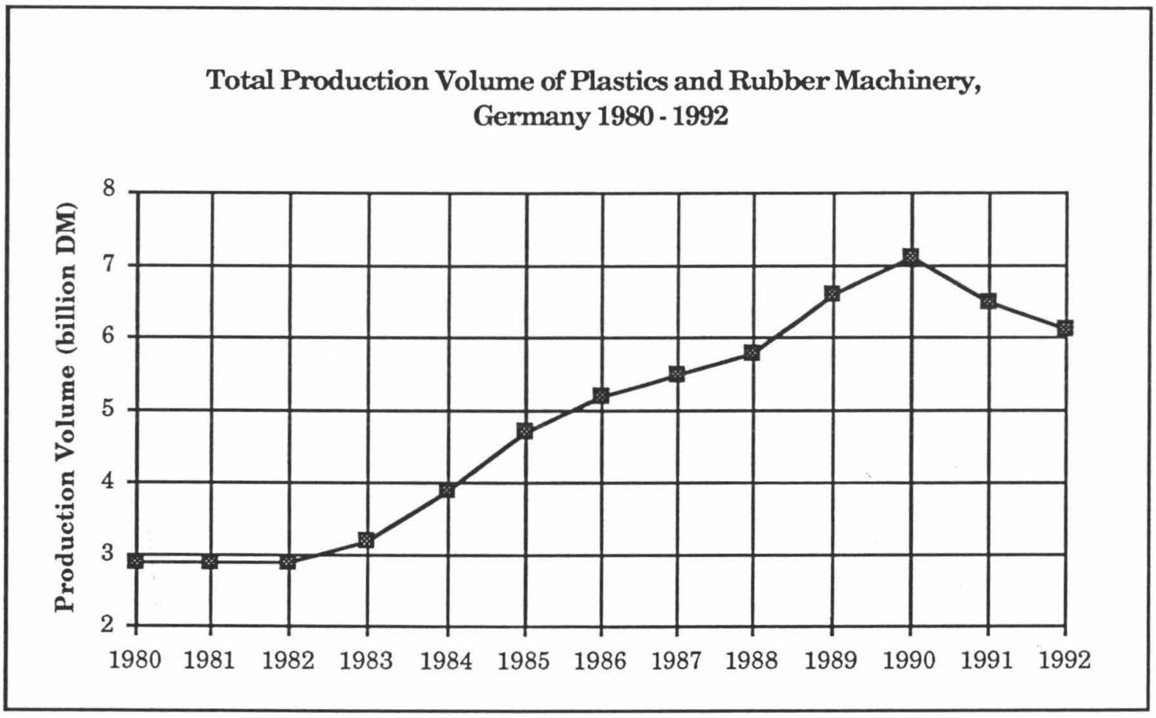
Figure 5.8 Major Resin Sales in U.S.A.

Comments:

Since 1988 the total resin consumption in United States has been unstable (see Figure 5.7), with even negative growth rate appearing in 1991 because of the apparent reduction in sales of low density polyethylene shown in Figure 5.8.

5.2.2 The recent trend in plastics machinery market

The situation and current trend of plastics industry can also be found from the changes in sales of plastics machinery. Since German manufacturers of rubber and plastics machinery supply more than one third of the world demand, followed by Italy, Japan and the USA with global shares of around 26%, 15% and 6% respectively[3], the production of plastics machinery in Germany indicates the global market changes and the investment trends of techniques and equipment in the plastics industry.



Source: Modern Plastics, June 1992.

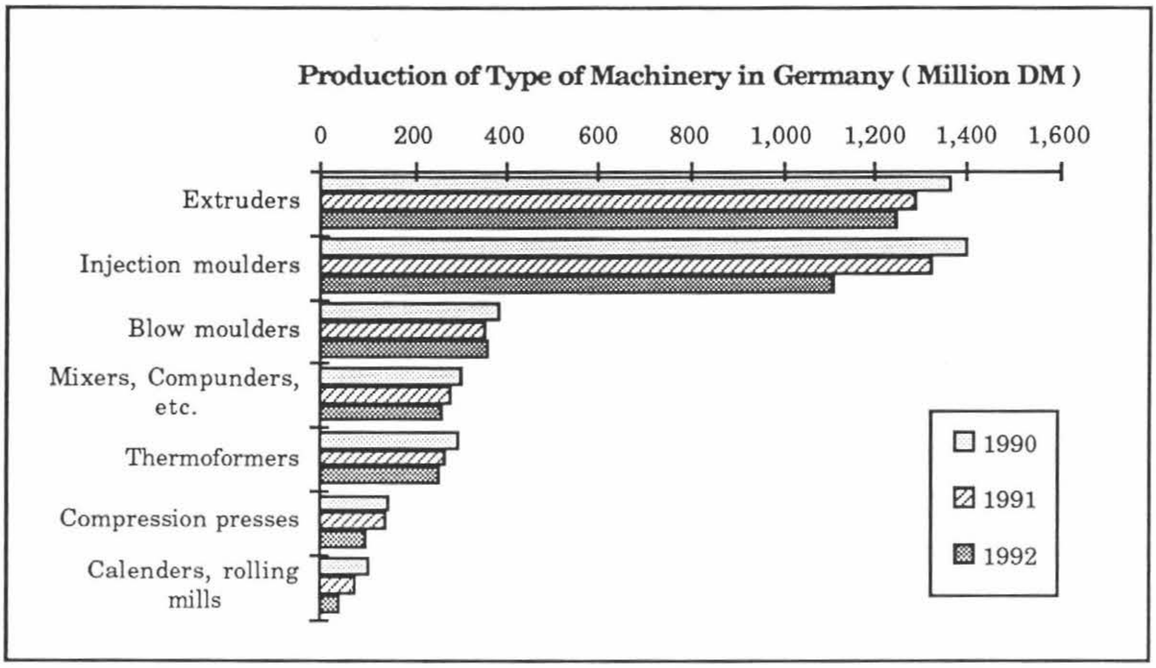
Figure 5.9 Production of Plastics Machinery in Germany

Comments:

(1) Germany, the world's biggest machine maker, suffered a second year of declining production in 1992 due to the demand weak for plastics processing machinery (see Figure 5.9).

(2) Extruders and injection moulders were the major products of plastics machinery and most widely used polymer processing

methods, but both of them suffered a significantly reduction in sales in 1992 (see Figure 5.10).



Source: Modern Plastics, June 1992.

Figure 5.10 Production of Major Types of Machinery in Germany

(3) Because total resin consumption is still increasing, the reduction in demand for resin processing equipment reflected the shortage of new technology in this area. What can be expected for the future technique requirement was expressed by Bernd[4] as:

- R&D efforts of innovations in machinery construction.
- Quality control and continuous improvement in polymer processing methods.

5.3 Summary

The plastics industry plays an important role in the manufacturing industry because of its close relationship with many other industries. The resin sales and demand for plastics machinery indicated that the world-wide recession continues to plague most of the major plastics production countries such as Europe, Japan and United States. How to increase competitiveness with technology innovation and how to retain constant high-quality criteria are becoming more important issues for the plastics industry. The assessment of innovation and technology management is one of the major prerequisites for technology development and competitiveness improvement.

Chapter 6
Profile of the New Zealand Plastics Industry

6.0 Introduction

This chapter summarizes the survey method used to assess the New Zealand plastics industry and provides some information relevant to the New Zealand plastics industry.

6.1 Background

It has been accepted that modern civilization has entered into the plastics age, and that plastic products can be found everywhere. With increasing competitiveness in the global market the New Zealand plastics industry is playing a more important role in the manufacturing industry. In 1992, the production of the New Zealand plastics industry amounted to $1 billion. Annual exports of plastic products exceeded $80 million[1], and this industry also provided some 6000 jobs. Due to its importance in New Zealand manufacturing industry, evaluation of the New Zealand plastics industry is necessary.

6.2 Questionnaire

In order to carry out an assessment of the New Zealand plastics industry, the questionnaire was designed to collect the following information:

- The current situation (See Chapter 6).
- Potential problems and attitudes (See Chapter 7).
- The current status of manufacturing technology within the plastics industry and where technology transfer from overseas may be required (See Chapter 8).

- The competitive characteristics of company by a series of inter-related questions (See Chapter 9).

The survey form was divided into three parts, namely:

Part A General Enquires:

1) Personnel.

2) Technical linkage.

3) Investment in technology.

4) Key issues.

Part B Techniques and Processes:

1) Specific techniques and processes

2) General techniques and processes

Part C Competitive Capabilities:

1) Important strategic directions.

2) Marketing practices.

3) Planning, control and appraisal methods.

4) Achieving competitive edge.

5) Management and engineering systems.

6) Supplier management.

The detailed version of the questionnaire is presented in Appendix I.

6.3 Samples

- Source

The initial source of the names of the companies to be surveyed was "The Plastics Industry Directory" published by Plastics Institute of New Zealand (PINZ) in 1993. The other source used was "The New Zealand Business Who's Who".

- Procedure

A questionnaire was sent out by mail to the general managers or managing directors of 169 companies which included nearly all the New Zealand plastics companies.

- Response

The overall response rate was 38.46% (65 replies from 169 companies) by the cut-off date.

Table 6.1 shows the reply distribution of the companies whose size could be determined.

Company Size (Staff Number)	Number of Companies	Useful Respondents	Reply Percentage by Company Size
Over 200	8	6	75.00%
100 - 199	7	5	71.43%
50 - 99	21	14	66.67%
20 - 49	35	17	48.57%
10 - 19	25	12	48.00%
Under 9	19	11	57.89%

Table 6.1 Distribution of Responses by Company Size

6.4 Company type and personnel percentage

The company size was sorted into four groups based on company staff numbers. The company type and personnel percentage were related to the company size.

- **Company type**

As shown in Figure 6.1, there was a very high percentage of importer & distributor in small size companies, and nearly all the medium or large size companies were manufacturers.

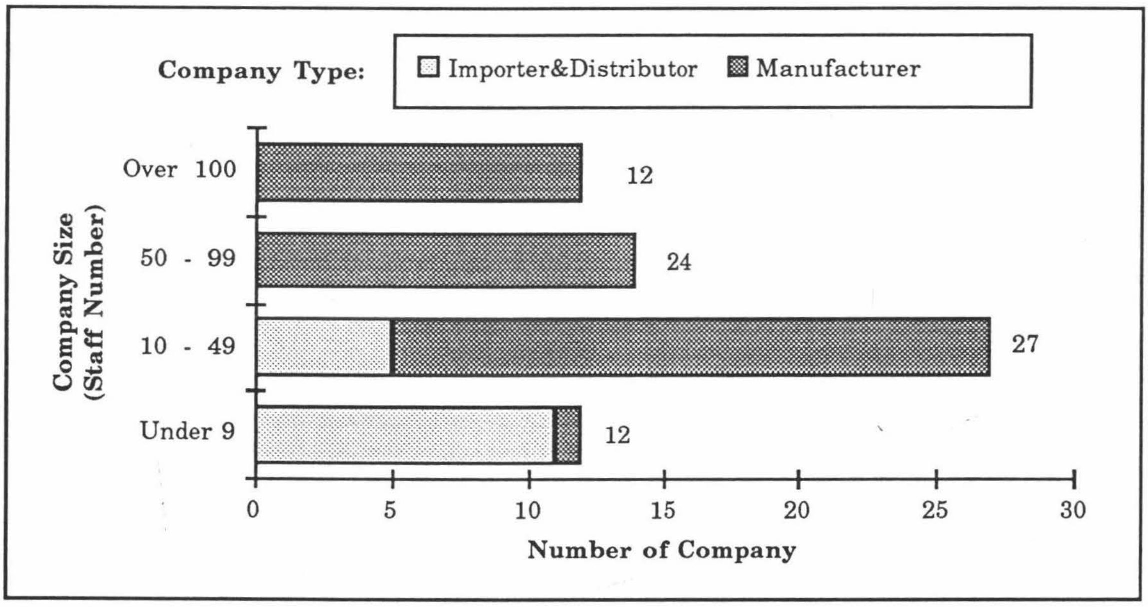


Figure 6.1 Company Type Based on Company Size (Staff Number)

- **Personnel percentage**

The personnel percentage by company size is presented in Table 6.2 and Figure 6.2. Because most small companies were both importers and distributors, the percentage of executive, administration, and sales was relatively high and the percentage of skilled and unskilled people was relatively low. Nearly all the large companies were manufacturers and therefore, have low percentage of executive and a high percentage of skilled and unskilled people compared with the small companies.

Staff Member	Personnel Percentage by Company Size			
	Under 9	10 - 49	50 - 99	Over 100
Executive	27%	10%	4%	3%
Sales	28%	12%	7%	9%
Technical	9%	9%	5%	9%
Administration	27%	16%	8%	7%
Skilled	3%	28%	36%	39%
Unskilled	7%	26%	39%	34%

Table 6.2 Average Personnel Percentage by Company Size

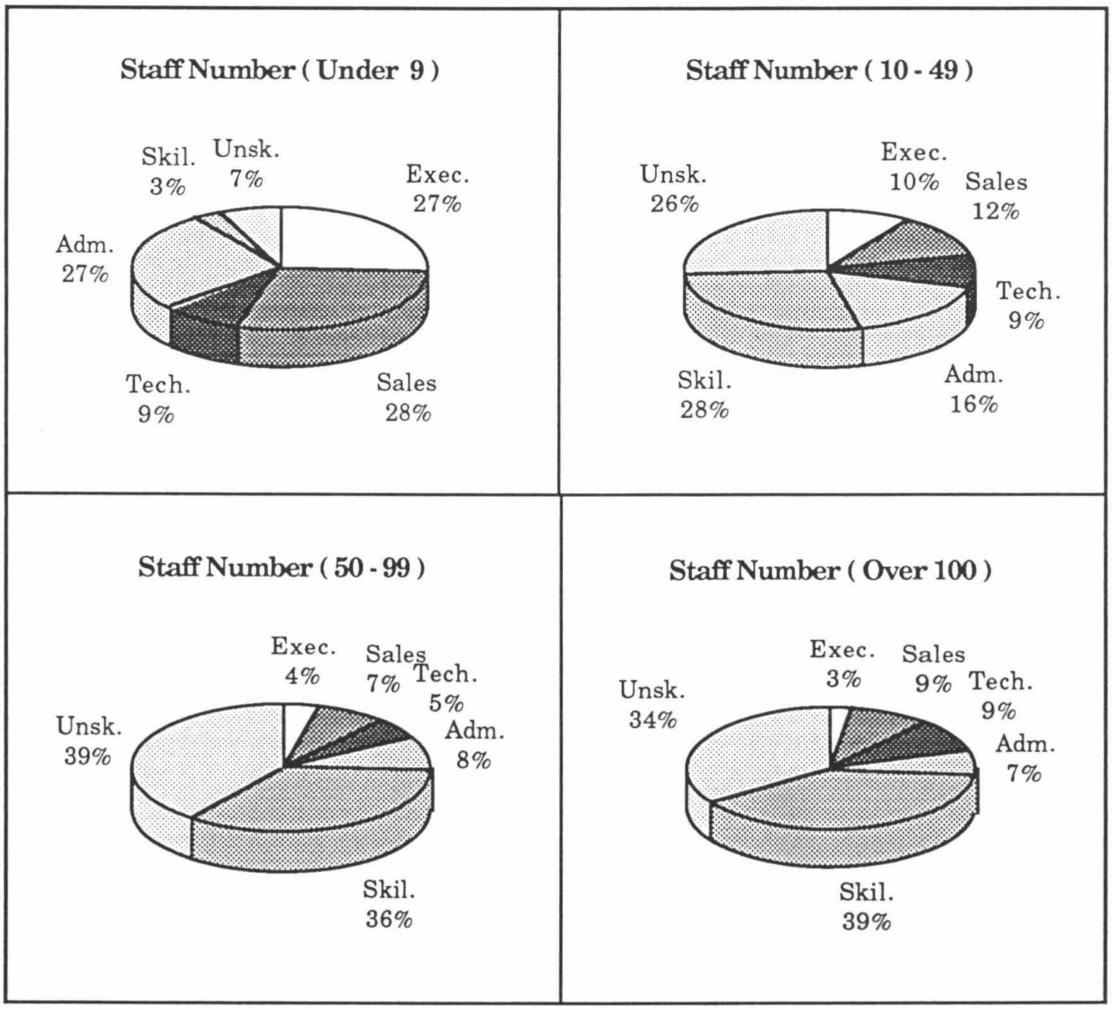


Figure 6.2 Average Personnel Percentage by Company Size

6.5 linkages

The respondents were asked to answer the following three questions related to the linkages that the companies had with overseas companies.

(1) Is your company a subsidiary of an overseas company?

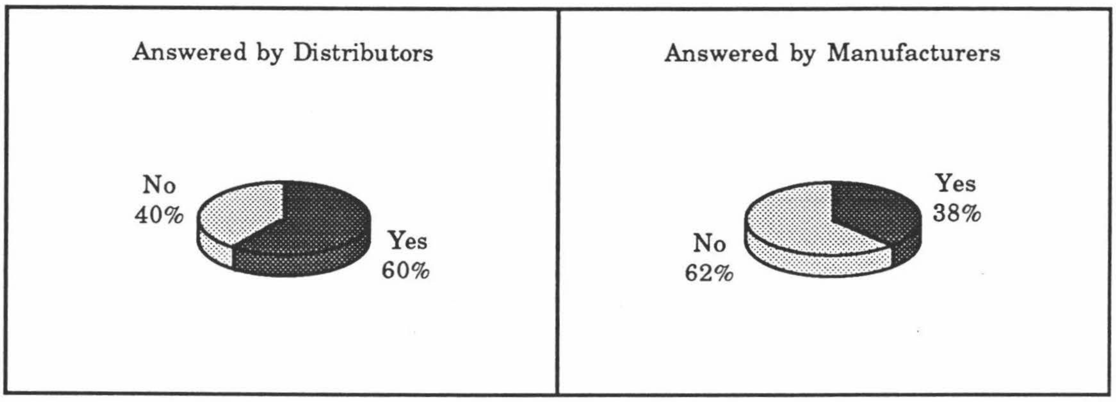


Figure 6.3 Linkages (1)

(2) If so, is that parent company an important source of technology?

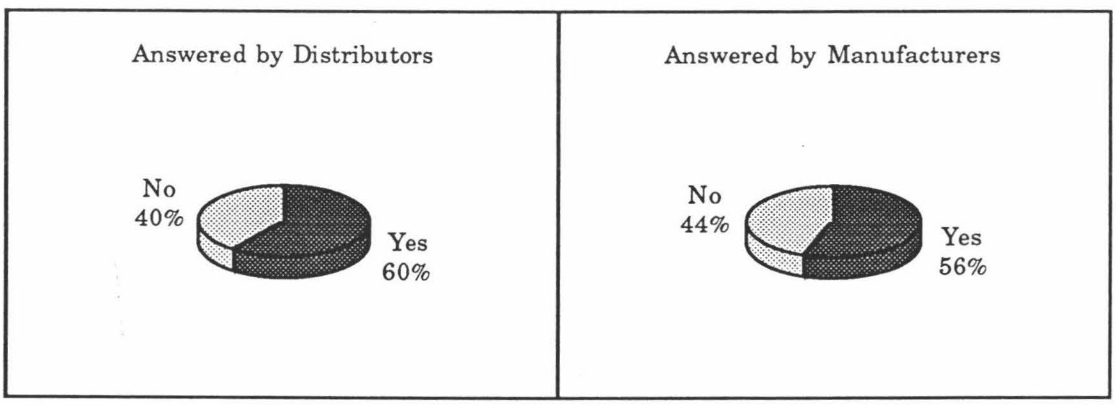


Figure 6.4 Linkages (2)

(3) Do you have important links with other overseas companies?

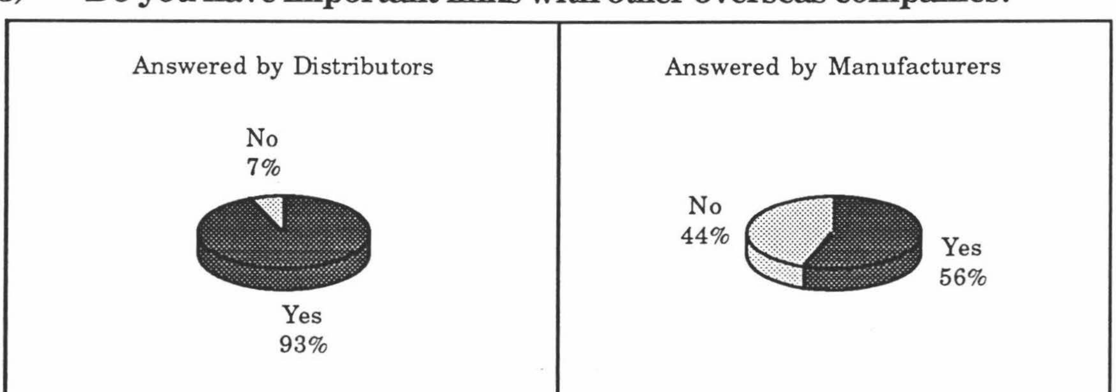


Figure 6.5 Linkages (3)

6.6 Investment in technology

The investment in technology was evaluated from a series of items based on their investment as a percentage of company turnover.

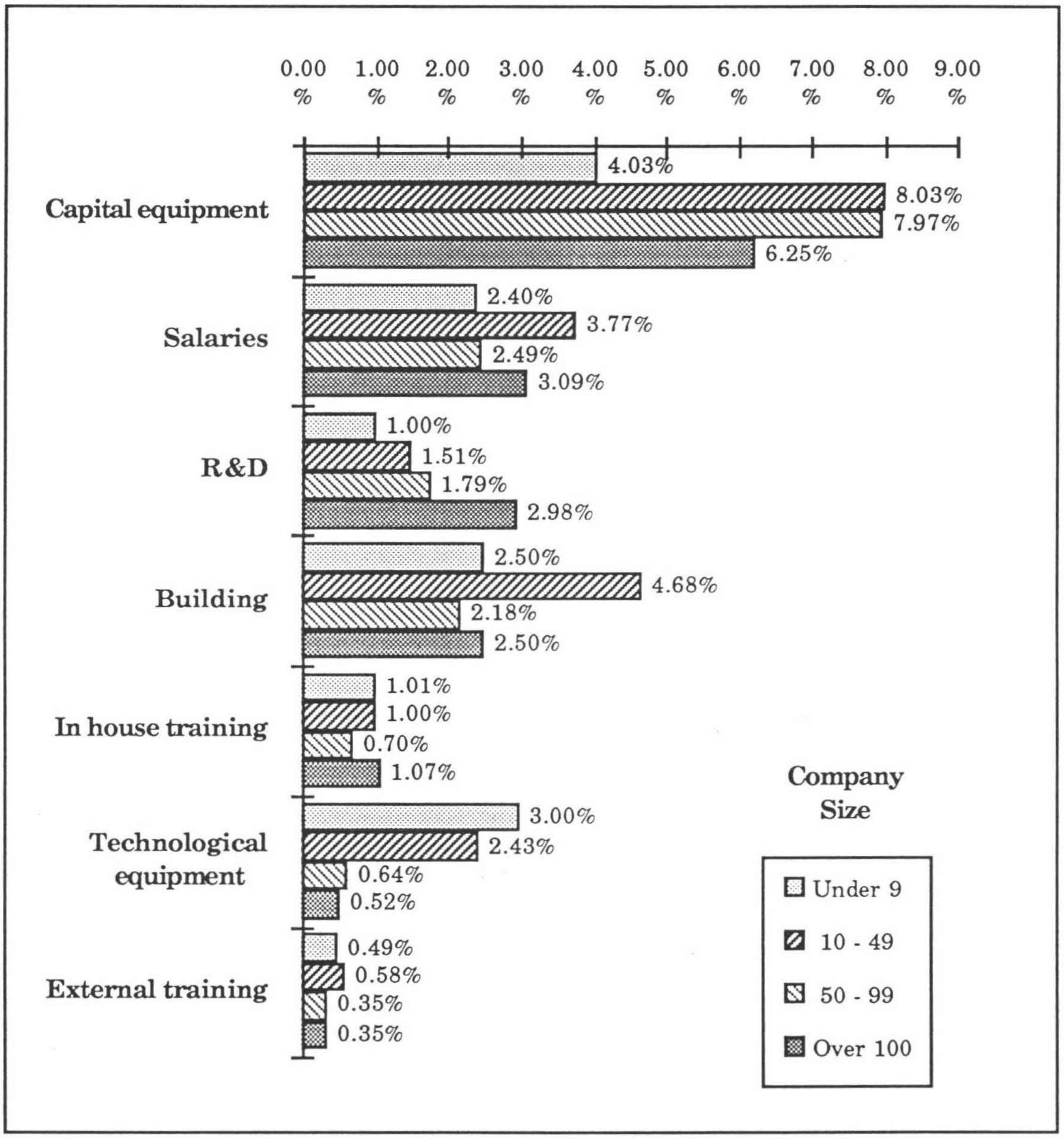


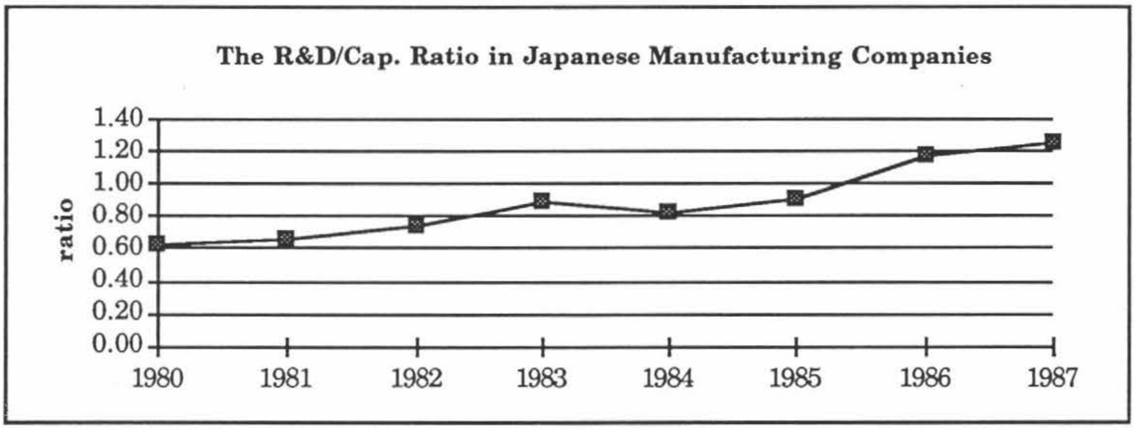
Figure 6.6 Investment in Technology
Based on Percentage of Company Turnover

As shown in Figure 6.6, the percentage of capital equipment in technology investment was higher than other items. However, small companies had a relatively high percentage of investment in technological equipment.

Comments:

(1) The ratio of R&D to capital investment

For international comparison, the change of average R&D/capital investment ratio of all Japanese companies is presented in Figure 6.7. The ratio of R&D to capital investment increased from 0.62 in 1980 to 1.26 in 1987, meaning that Japanese manufacturing companies were spending 26 per cent more on R&D than an equipment.



Source: F. Kodama, Analyzing Japanese High Technologies, 1991.

Figure 6.7 The R&D/Cap. Ratio in Japanese Manufacturing

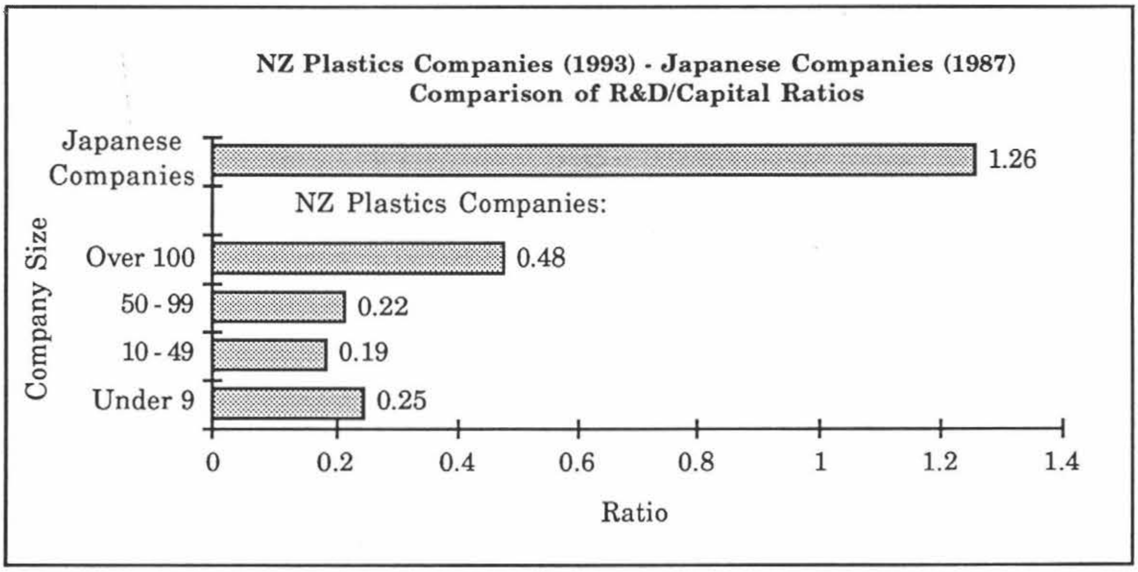


Figure 6.8 International Comparison of R&D/Cap. Ratio

The ratio of R&D to capital investment in New Zealand plastics companies was very low compared with Japanese companies in 1987 (see Figure 6.8).

As described by Kodama[2], today's Japanese leading companies have entered into the stage where they survive by adapting to the changing environment, based on consistent, dependable R&D. Whether New Zealand plastics companies need to follow the Japanese pattern in technology investment should be given further study.

(2) R&D spending by percentage of GDP

The low investment in R&D is a widespread problem not only in the plastics industry but also in other New Zealand manufacturing industries. This can be seen from the international comparison of gross expenditures on R&D as a percentage of gross domestic product (GERD/GDP) shown in Table 6.3.

Countries	1981	Countries	1989
United States	2.45	Germany	2.88
Germany	2.42	Switzerland	2.86
Uk	2.41	United States	2.82
Sweden	2.30	Japan	2.80
Switzerland	2.29	Sweden	2.76
Japan	2.14	France	2.34
France	1.97	Uk	2.25
Netherlands	1.88	Netherlands	2.17
Belgium	1.42	Norway	1.85
New Zealand	1.40	Finland	1.80
Norway	1.29	Belgium	1.64
Canada	1.21	Denmark	1.53
Finland	1.19	Austria	1.40
Austria	1.17	Canada	1.35
Denmark	1.10	Italy	1.25
Australia	1.01	Australia	1.23
Italy	0.87	Iceland	1.00
Yugoslavia	0.76	Yugoslavia	0.92
Ireland	0.73	**New Zealand**	0.91
Iceland	0.66	Ireland	0.81
Spain	0.40	Spain	0.75
Portugal	0.34	Portugal	0.50
Greece	0.21	Greece	0.47
Average	**1.37**	**Average**	**1.66**

Source: F. Edwards [3], R&D Spending, 1991.

Table 6.3 Rank Order of Countries by Percent of GDP Spend on R&D

It is well known that there are few examples of world class, specialized technology bases in New Zealand. One reason is New Zealand's relatively low level of investment in research and development. As indicated by Edwards[3], in 1981 New Zealand spent about 1.37% of its GDP on research and development, about the same as the average proportion of GDP spent on research and development by the other OECD countries. Whereas the other OECD countries increased their proportion to an average of 1.66% by 1989, New Zealand reduced its proportion of GDP spent on research and development to 0.9% by 1989 .

It is essential that New Zealand adopt a focused, strategic approach in applying research and development in manufacturing to fostering its competitiveness. With the possibility of generating a technology advantage to match, and exceed international innovative effort.

6.7 Product group statistics

Plastics product groups and statistics from the survey data are presented in Table 6.4 and Figure 6.9.

	Number of Respondents		
Plastics groups	Distributor	Manufacturer	Total
Resins	16	3	19
Other plastic articles	2	13	15
Foamed materials	4	10	14
Bottles, jars and similar rigid containers	0	13	13
Bags, sachets and other flexible containers	1	9	10
Films produced by extrusion process	3	6	9
Industrial containers over 10 litres in capacity	1	6	7
Plumbing ware	1	4	5
Thermoformable rigid sheets, including foils	2	3	5
Pipes,piping,tubing and hose	0	4	4
Profile shapes	1	3	4
Flexible sheetings, supported or unsupported	2	2	4
Kitchen and tableware and household utensils	0	4	4
Tapes, self-adhesive and others	1	2	3
Guttering and fittings	0	2	2
High pressure laminates	0	1	1
Cabinet makers and builders hardware	0	1	1
Floor coverings	0	0	0

Table 6.4 Plastics Product Group Statistics

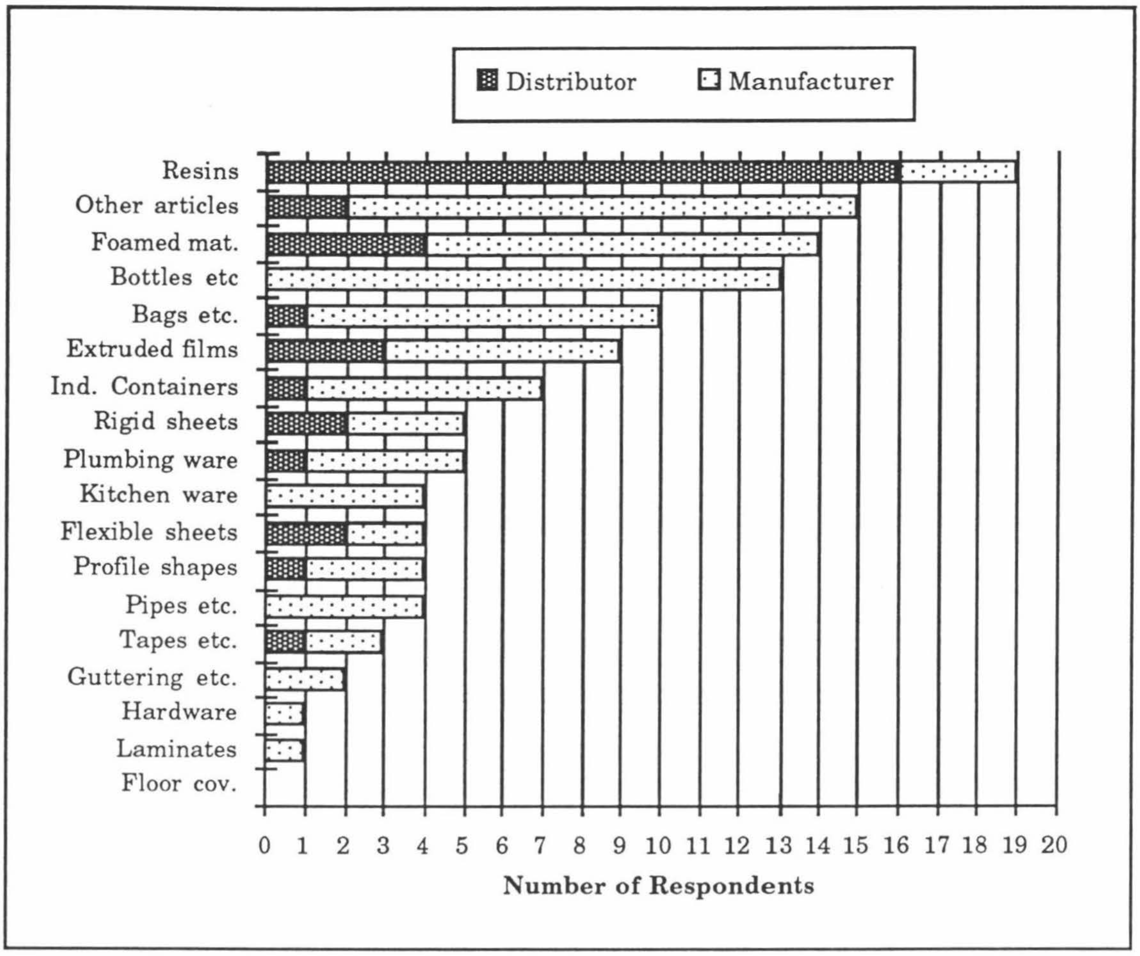


Figure 6.9 Plastics Product Group Statistics

Although resin is seen as a major product in the marketplace, most of the resin (80%) was imported from overseas in 1993. In terms of manufacturing, the major activities of the New Zealand plastics industry are plastic material processing and plastic product manufacturing, especially the production of packaging products. For example, nearly 100% of "bottles, jars and similar rigid containers" are manufactured in New Zealand due to the market need in the agriculture and food industry. It is also noted that "kitchenware, pipes, and guttering" are mostly supplied by New Zealand plastics companies because they are too expensive to import.

6.8 Average percentage of markets

The survey asked respondents to indicate the percentage of their products sold in New Zealand versus that sold overseas. This percentage varied with different companies. According to the survey data statistics, the average percentage of product export and domestic market are shown in Figure 6.10.

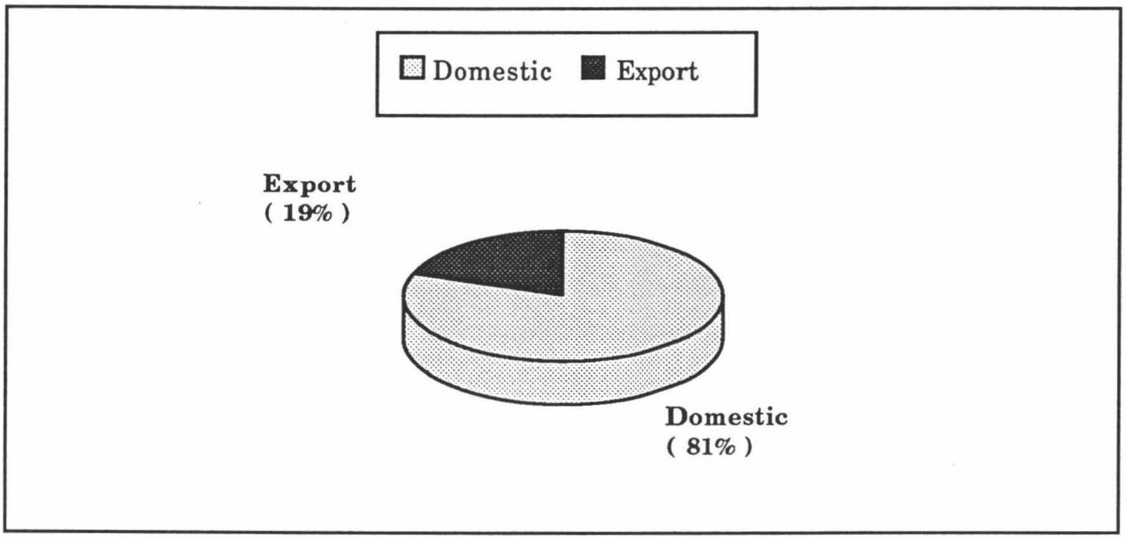
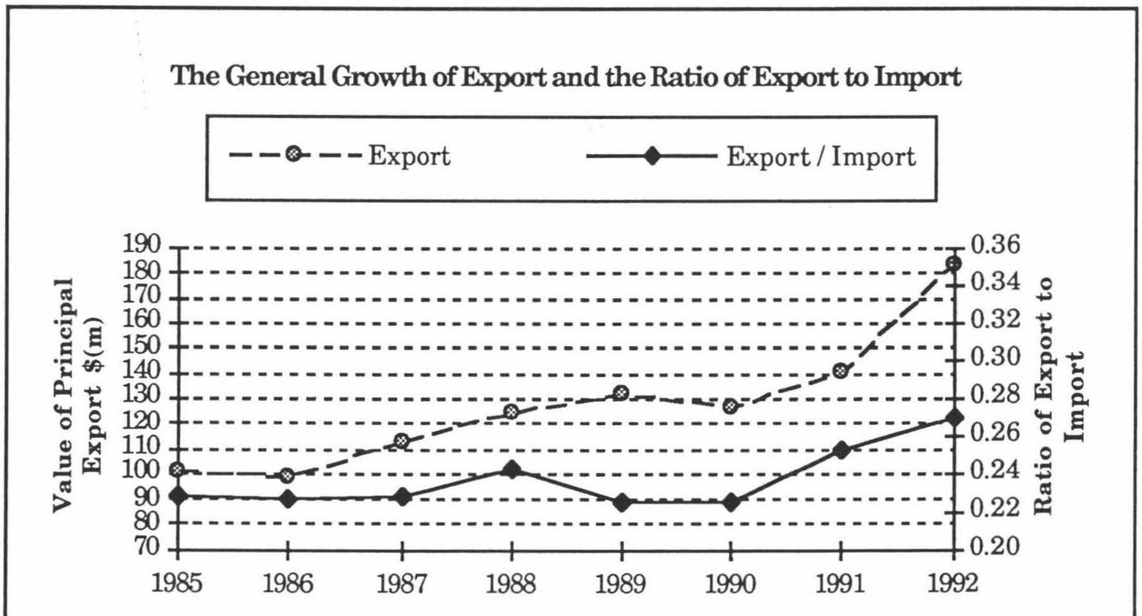


Figure 6.10 Product Market (1992)

The trend of export and import of plastic materials and articles in the New Zealand plastics industry can be presented by the general growth of export and ratio of export to import shown in Figure 6.11. It is noted that the ratio has been increasing since 1990, which indicates that the New Zealand plastics industry is improving its competitiveness in the global market.



Source: PCINFOS, Massey Computer Network, 1993

Figure 6.11 The Trade of Plastic Materials and Articles in the New Zealand Plastics Industry

Chapter 7
Key Issues in the New Zealand Plastics Industry

7.0 Introduction

This chapter summarizes the comments given by the survey respondents on the key issues raised by four questions below:

(1) Do you have any problems in the following areas?

- Keeping up with technology.
- People skills.
- Shortage of resources (capital , personnel , buildings , equipment, and technology).

(2) For the areas in which you have problems, what are you doing to solve the problems?

(3) Where do you think the critical technology changes are likely to be implemented for the New Zealand plastics industry?

(4) Do you think the tool and die making has become an important part of New Zealand plastics industry?

7.1 Major problems

The respondents were asked whether or not they had any problems in a series of areas. The findings are shown in Figure 7.1. It is noted that most (39 out of 65) companies regarded people skills as their major problem, followed by keeping up with technology.

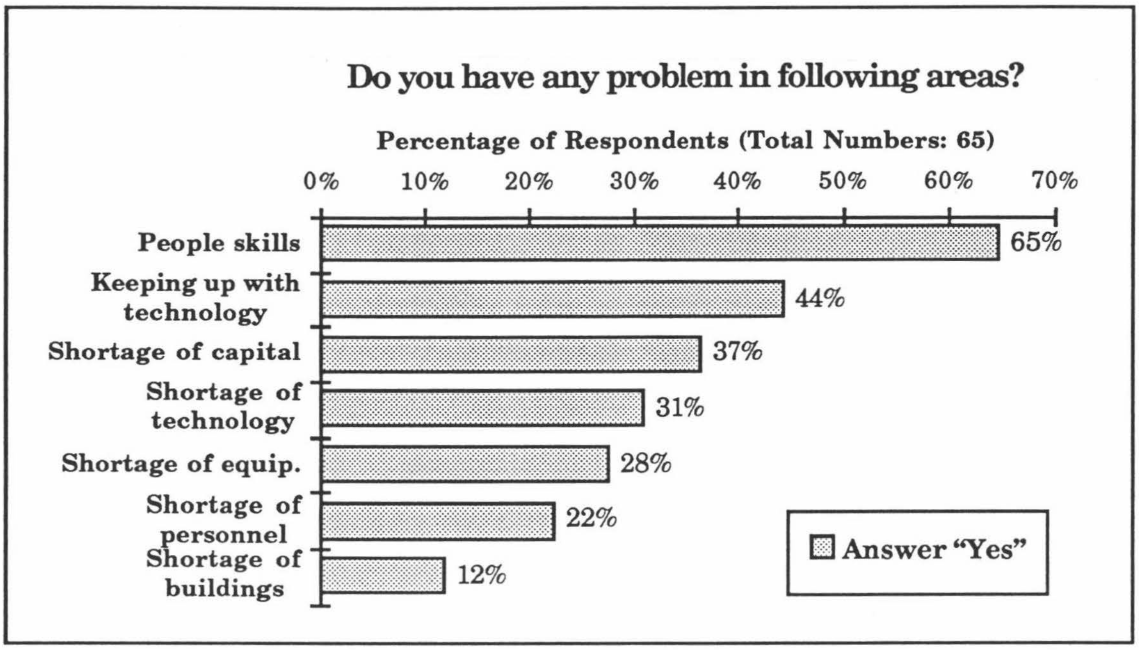


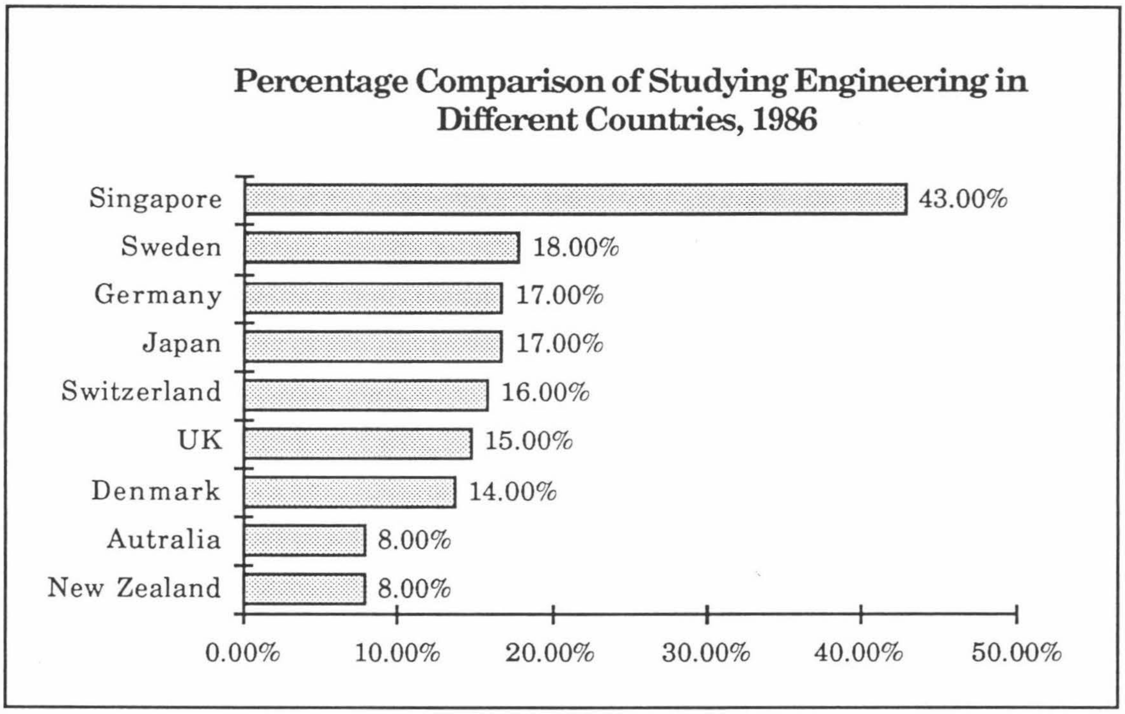
Figure 7.1 Assessment of Problems

Comments:

Lack of people skills is known to be a widespread problem in the New Zealand industry. In his recent book , Graham (1991)[1] stressed that:

> *New Zealand faces fundamental human-resource challenges. We have not invested aggressively in creating the pools of human-resource skills needed to be internationally competitive. The rate of participation in the workforce is low as are the levels of training and skills. Many economically active people have emigrated, particularly to Australia. The education system is not well designed to develop economically useful skills. Limited management training, convoluted and antagonistic labour relations, low skill levels, and the nature of the industries in which we compete have contributed to one of the lowest levels of labour productivity in the industrialized world.*

For the New Zealand industry, two basic needs for the people skills are technical skills and management skills. Technical skills have become increasingly important in modern international competition, yet New Zealand trains relatively few engineers. In 1986, fewer than 10% of tertiary students were studying engineering[1]. This was significantly behind Singapore, with 43%, Sweden with 18%, and Germany and Japan with 17%. Both Denmark and Switzerland had a significantly higher percentage of students studying engineering than New Zealand. Canada and Australia, two other nations that tend to export primary products, had figures similar to New Zealand (see Figure 7.2).



Source: G. Crocombe, Upgrading New Zealand's Competitive Advantage, 1991.

Figure 7.2 Studying Engineering in Different Countries, 1986

Another basic need is management education. International success will require a fundamentally different and more sophisticated orientation to competition than New Zealand management has been used to. Opportunities for management education, while improving rapidly in recent years, remain limited. One New Zealand study found that while 72.6% of the local workforce had no formal educational qualifications, some 65% of managers had no formal educational qualification either[2]. Therefore, improving management skills by education is a critical need.

7.2 Problem solution

The comments given by the respondents on the question of problem solution are summarized in the following sections.

7.2.1 People skills

There were two major solutions suggested by the respondents to the *shortage of people skills*. One was *training* and another was *finding skilled people*. A sample of responses is included in next tables.

(1) Respondents' views on *training*.

- We are developing in-house training for technical skills and using "consultants" and trainers to improve personal skills and team building.
- Embarking on a major training programme and TQM technology. Forming an international alliance.
- Training of apprentices by external providers - e.g. Polytechnic's is not adequate. They need retraining in-house. Also some lecturers are incompetent.
- We have an ongoing policy of training apprentices in plastics engineering. We have recently decided to double our intake.
- Main problem is high quality printing skills. Solution is in identifying training needs and carrying out that training. This is in the process of being carried out.
- Establishing an independent training department to focus on the training need company wide.

Table 7.1 Comments on Problem Solution (a)

(2) Respondents' views to *finding skilled people.*

• Attempt to employ key person.
• TQM philosophies. Recruiting of suitably qualified engineers/technologists.
• Employing more qualified/highly skilled staff.
• We try to select people well and educate them over the long term.
• Taking on board as many technical people as possible and training them.

Table 7.2 Comments on Problem Solution (b)

Comments:

Training is the basic solution to the problem of people skills. In some countries, such as Germany and Switzerland, training programmes have made significant contributions to the human-resource base. Most new Zealand companies have recognized the importance of people skill training and have also carried out some training programmes. However, lack of people skills is still a major problem. The reason that current training programme can't satisfy the actual need is that New Zealand's industrial training structure has often not kept pace with the instruction in up-to-date technologies and skills. That is why some companies try to "find" and "employ" well educated people from outside the company to solve this problem.

7.2.2 Keeping up with technology

Due to relatively low investment in R&D in the New Zealand plastics industry (see Figure 6.5), the solutions to *keeping up with technology* suggested by respondents were *buying into technology* and *networking with overseas companies*. Only a few comments were supplied on this area and these comments are listed in Table 7.3.

- Selling equipment which is not up-to-date, and buying in partly finished product with up-to-date specification.
- The market will continue to drive the technology information. However visits to overseas "Plastics Fairs" helps to "cement in" new advances in technology plant and materials. K92 Plastics Fair in Germany was an excellent venue for this and particularly for recycling programmes set up by various groups, companies or countries. Unfortunately we have little capital to invest in such equipment. This is the only limiting factor we have to live with.
- Overseas books, manuals, suppliers information. Using the telephone to call raw material suppliers overseas and asking them about ways to solve problems.
- Reading and sending staff to trade shows overseas.

Table 7.3 Comments on Keeping up with Technology

Comments:

Technology transfer was seen as a major solution to the keeping up with technology. It should be noted that the appropriate technology transfer depends on an assessment of the current status of the technology skills in the workforce and the status of technical facilities and equipment used, compared with the world standard. Chapter 8 will discuss this issue in more detail.

7.3 The critical technology changes

Survey respondents were also required to comment on the question "Where do you think the critical technology changes are likely to be implemented in the New Zealand plastics industry?". According to samples of the respondents' views (see Appendix II), some areas of critical technology changes are listed in Figure 7.3.

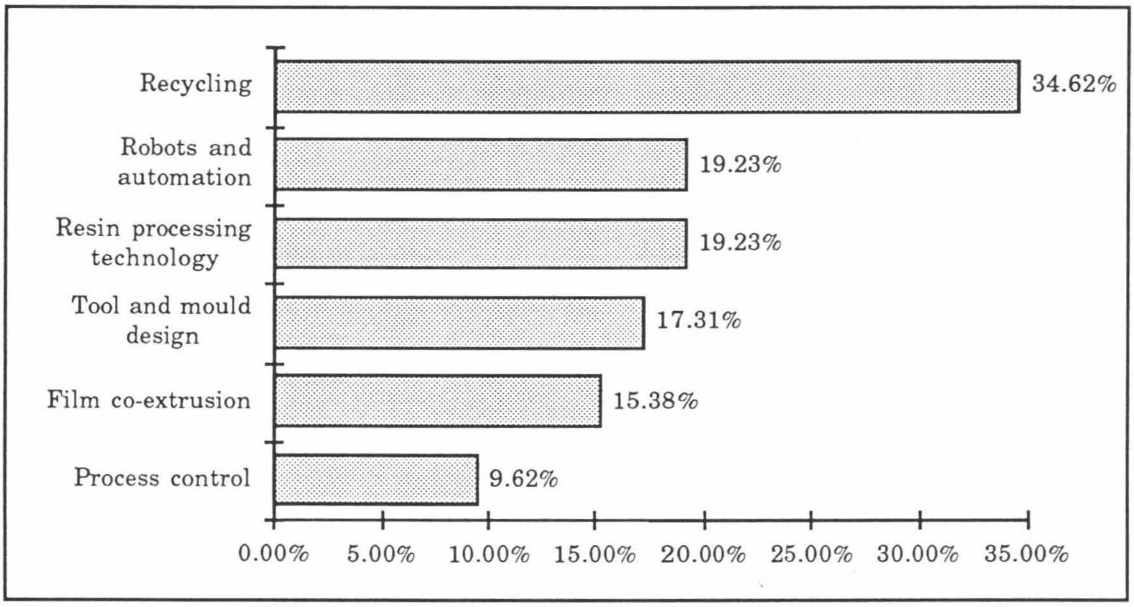


Figure 7.3 Respondent's Views of Critical Technology in Plastics Industry

Comments:

Recycling was seen as a major area of critical technology change in the plastics industry. Most respondents were concerned with the environmental issues, for example, "recycling - public image and knowledge of the efficient use of plastics", "environmentally friendly products", "plastics becoming recyclable and reusable in food grade products", "the recycling of waste/used materials into other forms of products can overcome adverse public opinion on the use of plastics" etc.

Robots and automation, resin processing technology, tool and mould design, and film co-extrusion were also seen as areas of technology changes in the plastics industry.

7.4 Tool and die making

Before sending the survey question, we had been advised that improving tool and die making is a critical need in the plastics industry. For this reason, all the companies participating in this survey were asked to give their comments on whether tool and die making is an important part of the New Zealand plastics industry. As described in the following table (Table 7.4), nearly all the respondents (83%) thought that tool and die making is important.

Is tool&die making an important?	Yes	No	No Answer
Number of answer	54	3	8
Percentage of answer	83.08%	4.62%	12.31%

Table 7.4 Evaluation of Tool and Die Making

According to the comments given by respondents who thought the tool and die making was a critical need in the plastics industry (see Appendix III), tool and die making was seen as one of the critical factors to improve the competitiveness in terms of product quality, cost, lead time, and new product development. Some relevant comments are presented in Table 7.5.

7.5 Summary

As a summary of this chapter, the following key issues should be given more emphasis on the New Zealand plastics industry:

- People skills is one of the major problems. Improving the training and education system is urgently needed.

- The critical technology changes for the New Zealand plastics industry are likely occur in a series of areas, such as recycling and resin process technology, robotics and automation, tool and mould design, film co-extrusion, and process control.

- Tool and die making is an important part of the New Zealand plastics industry.

• The product is only going to be as good as dies and moulding.
• Without quality tooling you can not get quality products at economic cycle time.
• Unless you have good tools you shouldn't be in the plastics manufacturing business.
• In an effort to become cost competitive, die making and design is a key component.
• Without a broad based and technology advanced tool making industry the plastics industry will falter.
• High quality tool and die making is a key to success. With the increasing requirement for ISO 9000 series acceptation, quality has become a major issue, and product quality revolves around tools and dies.
• Sometimes it is the limitation of the die or tool that prevents the product being made.
• It is essential to maintain quality, propriety ownership and for fast lead time.

Table 7.5 Comments on Tool and Die Making

Chapter 8
Assessment of Techniques and Processes

8.0 Introduction

The objective of this chapter is to evaluate the techniques and processes in the New Zealand plastics industry in order to understand where technology transfer from overseas, or research and development, may be required. Four pieces of information have been summarized from the survey, namely:

- The assessment of the *importance* of the particular technology to the products produced by New Zealand plastics companies.
- The assessment of company technological *status* relative to the world status.
- The gap between the *importance* and *status*.
- Further analyses of major techniques.

In the survey form "Part B", the questionnaire was divided into specific techniques and general techniques. The general techniques include Robots and Automation, Computer aided Design and Computer Aided Manufacturing (CAD/CAM), Flexible Manufacturing Systems (FMS), and Computer Integrated Manufacturing (CIM). These general techniques were discussed in Chapter 4. The specific techniques in the plastics manufacturing including injection moulding, extrusion, blow moulding, and calendering etc. were also discussed in Chapter 5.

8.1 The importance of techniques and processes

The importance of techniques and processes used in the New Zealand plastics industry have been ranked by the respondents in the survey. The scale used for *importance* was as follows:

Scale:

1 — Of marginal importance
2 — Important but not essential
3 — Important and essential in many applications
4 — Essential in all applications

Table 8.1 presents detailed data about the answer rate, average scores and standard deviation values for each question. The average scores are presented graphically in Figure 8.1.

Specific Techniques and Processes:	Answer Rate (%)	Average Scores	Std. Dev. Values
Injection moulders	49.23%	3.63	0.55
Extruders	40.00%	3.46	0.86
Hydraulic moulding presses	10.77%	3.29	0.76
Blow moulders	24.62%	3.19	1.05
Foaming machines	15.38%	3.00	1.15
Mixers	27.69%	3.00	0.97
Rolling mills	4.62%	3.00	1.73
Compounders	16.92%	2.73	1.10
Grinders	36.92%	2.71	1.12
Thermoformers	7.69%	2.67	1.03
Laminators	20.00%	2.62	0.87
Vacuum formers	9.23%	2.57	0.98
Compression moulders	4.62%	2.50	1.73
Calenders	6.15%	2.25	1.26
General Techniques and Processes:	Answer Rate (%)	Average Scores	Std. Dev. Values
FMS	46.15%	3.23	0.82
Robots and automation	41.54%	2.78	0.85
CAM	35.38%	2.61	0.94
CAD	43.08%	2.54	0.92
CIM	33.85%	2.14	1.08

Table 8.1 The Importance of Techniques and Processes

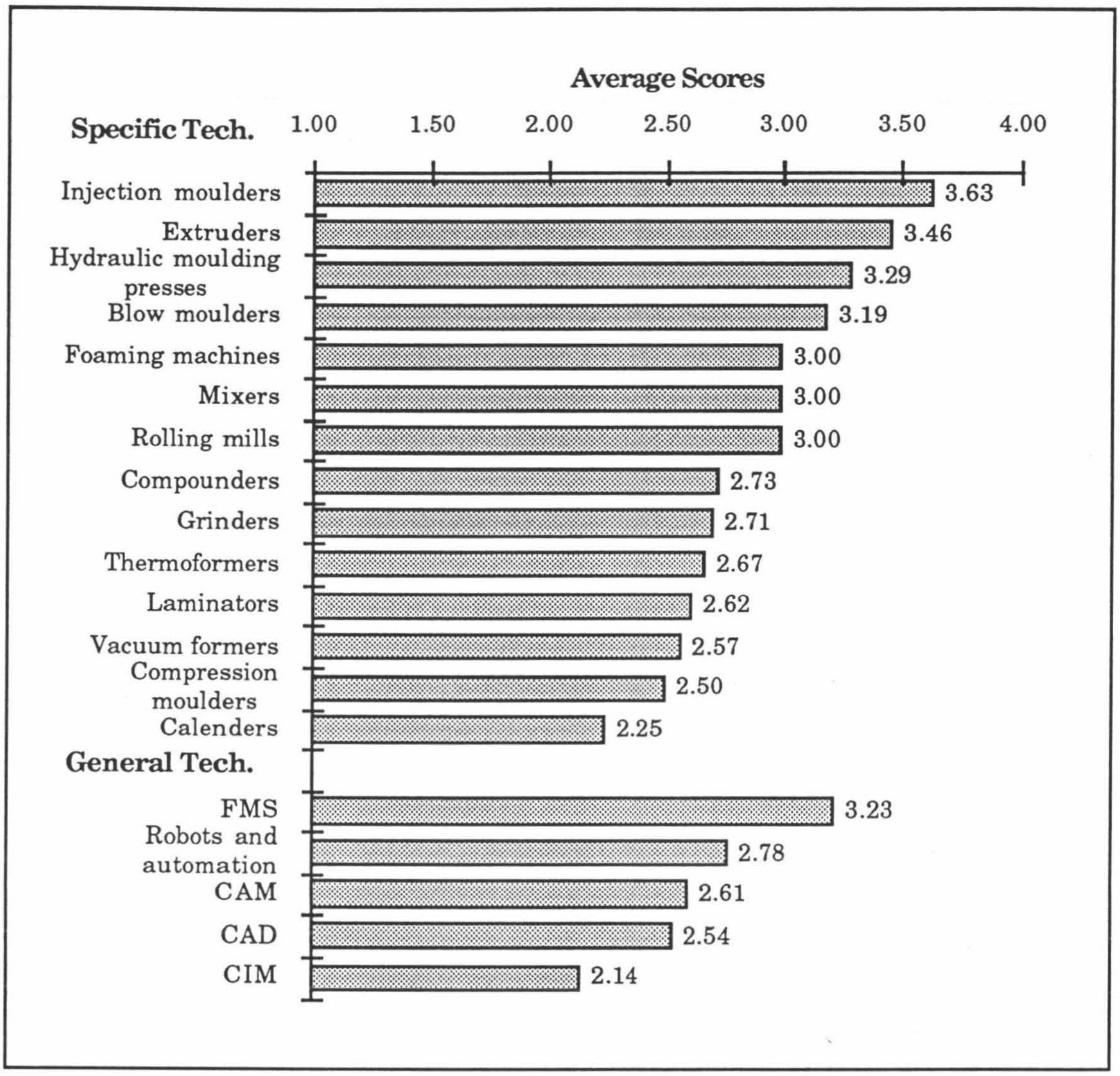


Figure 8.1 The Importance of Techniques and Processes

As shown in Table 8.1 and Figure 8.1, injection moulders and extruders were ranked first and second in importance for specific techniques and processes, because both methods were seen as the major techniques in the plastics industry. More detailed analyses of the survey data are given in Section 8.4.

For the general techniques and processes, the answer rate was relatively high. "Flexible Manufacturing Systems (FMS)" was ranked as the most important and essential, which means that FMS has been accepted by most companies as a key technique. For the international comparison, Japanese manufacturing companies ranked FMS as first in the ten most important action plans (see Table 3.2). Japanese companies invest heavily in factory automation and spend more management effort to increase design and volume flexibility[1].

8.2 The company status of techniques and processes

The current status of techniques and processes in the New Zealand plastics industry were also ranked by respondents in the survey (see Table 8.2 and Figure 8.2). The scale used for the *status* was as follows:

Scale:

1 — Little or no capability

2 — Some capability but below world standard

3 — General capability but below world standard

4 — Capability equal to average in the world

5 — Capability better than world average but not particularly outstanding

6 — Significantly better than the world average for this particular technique

Note:

This assumes the respondents know where the world standard is. The assumption may not be valid in all cases. To confirm observation in absolute term would require a benchmark. Most of the conclusions drawn from the data at this time rely on the relative magnitude of the data and are indication only.

Specific Techniques and Processes:	Answer Rate (%)	Average Scores	Std. Dev. Values
Injection moulders	46.15%	4.47	0.86
Extruders	36.92%	4.21	1.35
Rolling mills	3.08%	4.00	0.00
Foaming machines	12.31%	3.88	1.13
Hydraulic moulding presses	10.77%	3.71	0.49
Compounders	12.31%	3.63	1.85
Mixers	23.08%	3.60	1.55
Thermoformers	7.69%	3.60	1.52
Laminators	18.46%	3.58	1.31
Blow moulders	21.54%	3.57	1.45
Compression moulders	4.62%	3.33	2.08
Grinders	29.23%	3.32	1.16
Vacuum formers	7.69%	3.20	1.64
Calenders	6.15%	2.00	1.15
General Techniques and Processes:	Answer Rate (%)	Average Scores	Std. Dev. Values
FMS	40.00%	3.69	1.19
CAD	40.00%	2.88	1.45
Robots and automation	38.46%	2.56	1.16
CAM	33.85%	2.55	1.44
CIM	29.23%	2.05	1.22

Table 8.2 The Company Status of Techniques and Processes

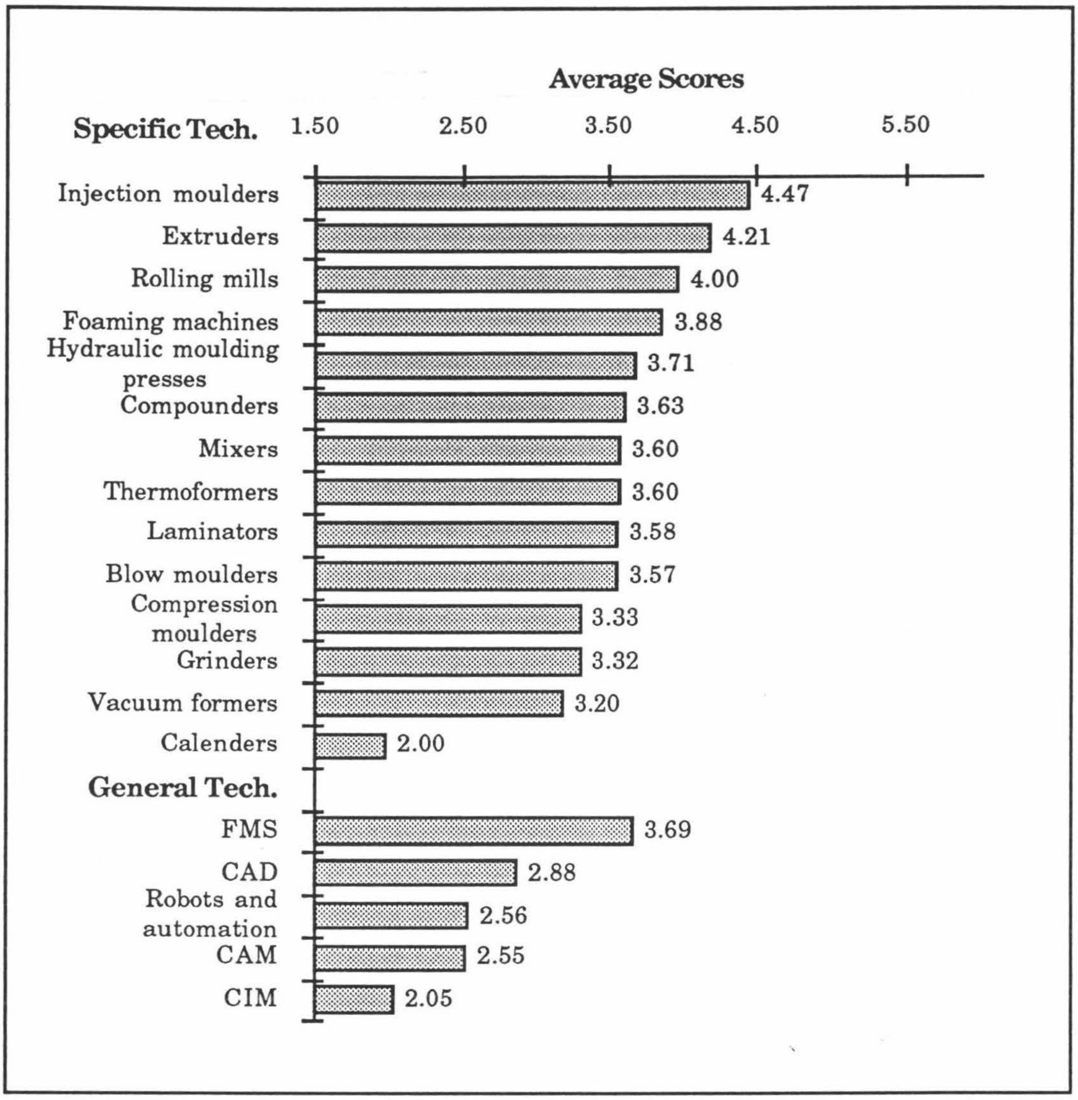


Figure 8.2 The Company Status of Techniques and Processes

From the survey results shown in Table 8.2 and Figure 8.2, it can be seen that "Injection moulders" and "Extruders" were ranked first and second in status for specific techniques, and "FMS" was ranked first in status for general techniques. The ranking order for status was the same as for importance. This indicates that plastics companies not only have recognized the importance of these techniques, but also have improved their technical status. According to the comments given by the survey respondents, extrusion and injection techniques have achieved the world leading status (see Appendix II). What should be noted is that "CIM" was ranked with the lowest score for both importance and status, perhaps because it is not seen as a necessary technique for many companies. A recent survey of CIM in the UK[2] noted that the computer based techniques were often implemented from an operational viewpoint . More detailed analyses of the survey data are given in Section 8.4.

8.3 The gap between the importance and the status

The evaluation scale used for importance and status was different. For example, importance used a 4 point scale and status a 6 point scale. In order to identify the difference between importance and status the average score for importance was multiplied by 1.5 to compare it with the average score for status.

The comparison results are shown in Table 8.3 and are also graphically presented in Figure 8.3.

Techniques and Processes	*Importance* Average Scores x 1.5	*Status* Average Scores	Gaps Between Imp. and Sta.
Calenders	3.38	2.00	1.38
Hydraulic moulding presses	4.94	3.71	1.23
Blow moulders	4.79	3.57	1.22
Extruders	5.19	4.21	0.98
Injection moulders	5.45	4.47	0.98
Mixers	4.50	3.60	0.90
Grinders	4.07	3.32	0.75
Vacuum formers	3.86	3.20	0.65
Foaming machines	4.50	3.88	0.62
Rolling mills	4.50	4.00	0.50
Compounders	4.10	3.63	0.47
Compression moulders	3.75	3.33	0.42
Thermoformers	4.01	3.60	0.41
Laminators	3.93	3.58	0.35
Robots and automation	4.17	2.56	1.61
CAM	3.92	2.55	1.37
CIM	3.21	2.05	1.16
FMS	4.85	3.69	1.16
CAD	3.81	2.88	0.93

Table 8.3 The Gaps Between Importance and Status

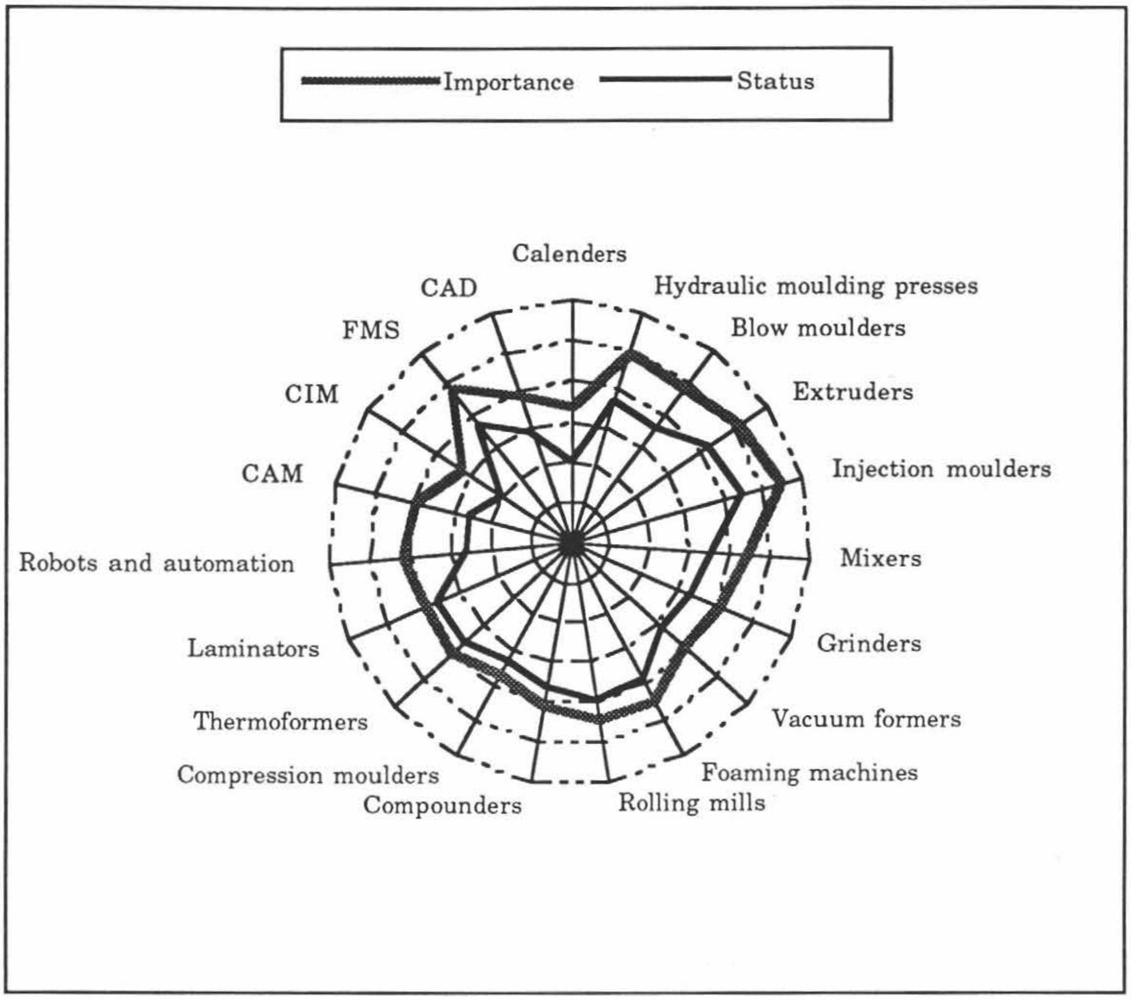


Figure 8.3 The Gap Between the Importance and Status

Techniques and Processes	Importance Average Scores	Gaps Between Imp. and Sta.	Weighted Measures Importance x Gap
Robots and automation	4.17	1.61	6.71
Hydraulic moulding presses	4.94	1.23	6.08
Blow moulders	4.79	1.22	5.84
FMS	4.85	1.16	5.63
CAM	3.92	1.37	5.37
Injection moulders	5.45	0.98	5.34
Extruders	5.19	0.98	5.09
Calenders	3.38	1.38	4.66
Mixers	4.50	0.90	4.05
CIM	3.21	1.16	3.72

Table 8.4 Weighted Measures of *top ten* Techniques and Processes

Comments :

(1) From observing the gap between the importance and status (Figure 8.3) and weighted measures (Table 8.4), it was found that the following techniques and processes are considered to be the important candidates for technology upgrading to improve competitive advantage:

- Robots and automation
- Hydraulic moulding presses
- Blow moulders
- Flexible manufacturing systems (FMS)
- Computer aided manufacturing (CAM)
- Injection moulds
- Extruders
- Mixers
- Computer integrated manufacturing (CIM)

(2) Although the gap between importance and status for calenders was assessed with the highest score, its importance and consequently its weighted measures were low and also answer rates for both importance and status were only 6.15%, which is relatively low compared with others. This indicates that answer rate is a factor to taken into account in assessing the weighted results. Further investigation of this is beyond the scope of this thesis.

(3) Although both injection and extrusion techniques were ranked first and second in status, their weighted measures were still ranked relatively high. This suggests that keeping up with world leading technology in these technical areas is important and further technology transfer is needed.

(4) Both importance and status of Computer Integrated Manufacturing (CIM) were ranked the lowest and this is of concern. A recent study by Mazany[3] indicated that implementing a CIM strategy is vital for New Zealand's economic fortunes, since it provides one key component by which many organizations can improve their operations to become internationally competitive. *Further investigation needs to be carried out to see why the New Zealand plastics companies ranked the CIM so low.*

8.4 Further analyses of major techniques

More detailed analyses of major techniques and processes based on the survey data are presented graphically in the following figures.

8.4.1 Injection Moulders

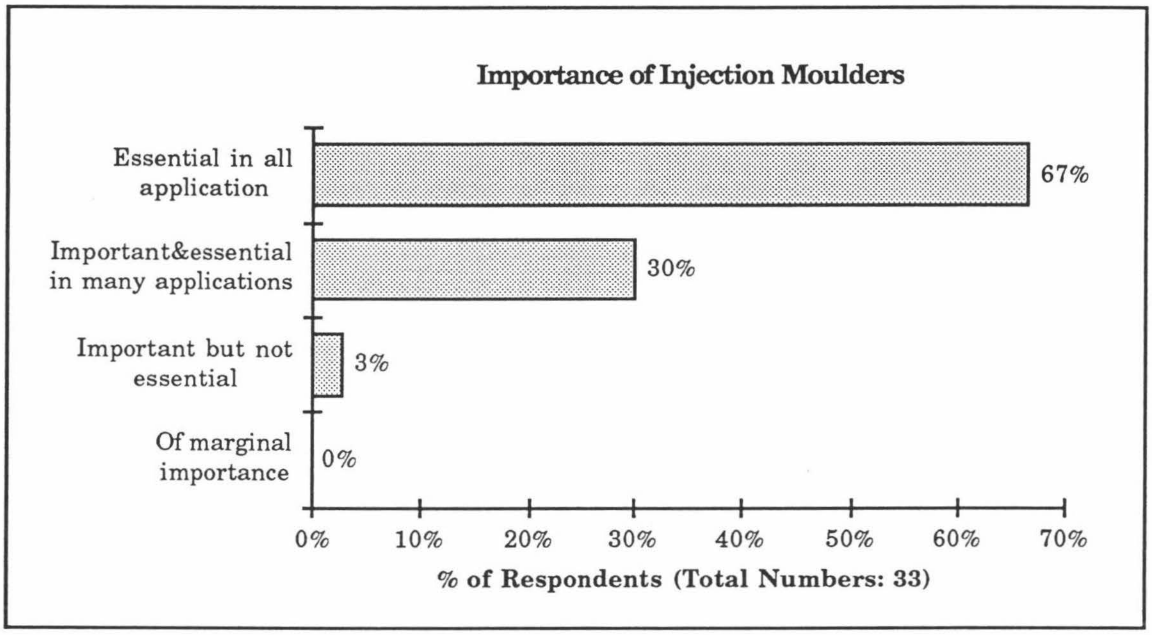


Figure 8.4 (a) Importance of Injection Moulders

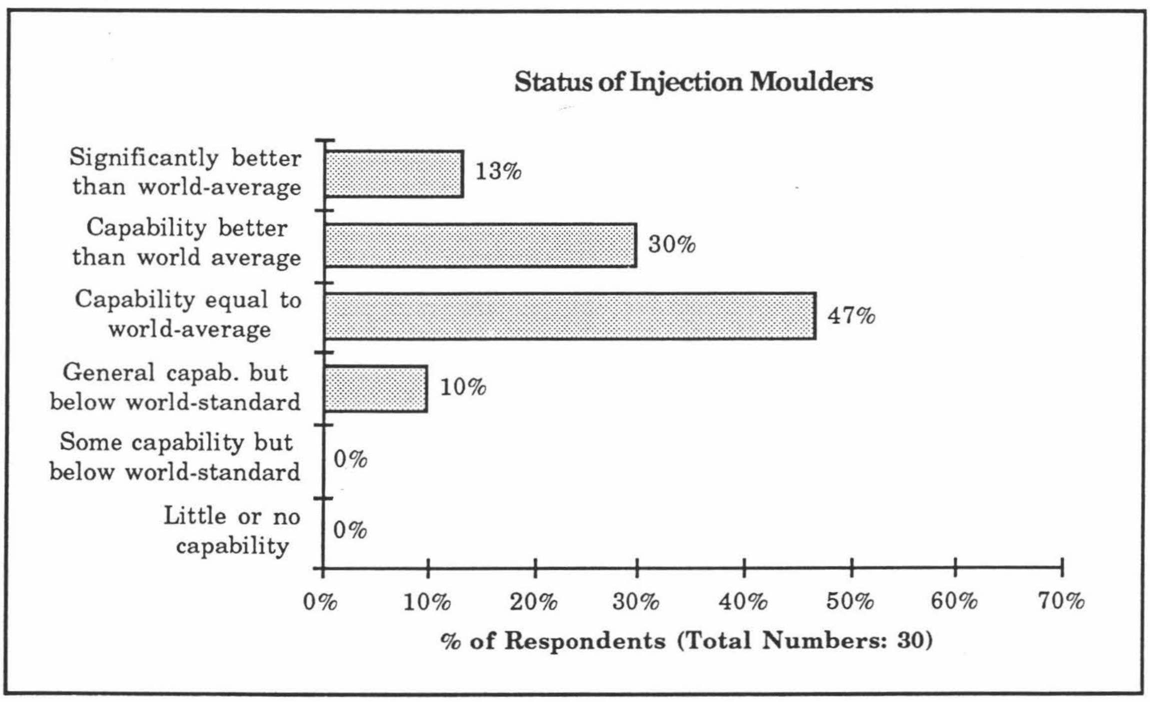


Figure 8.4 (b) Status of Injection Moulders

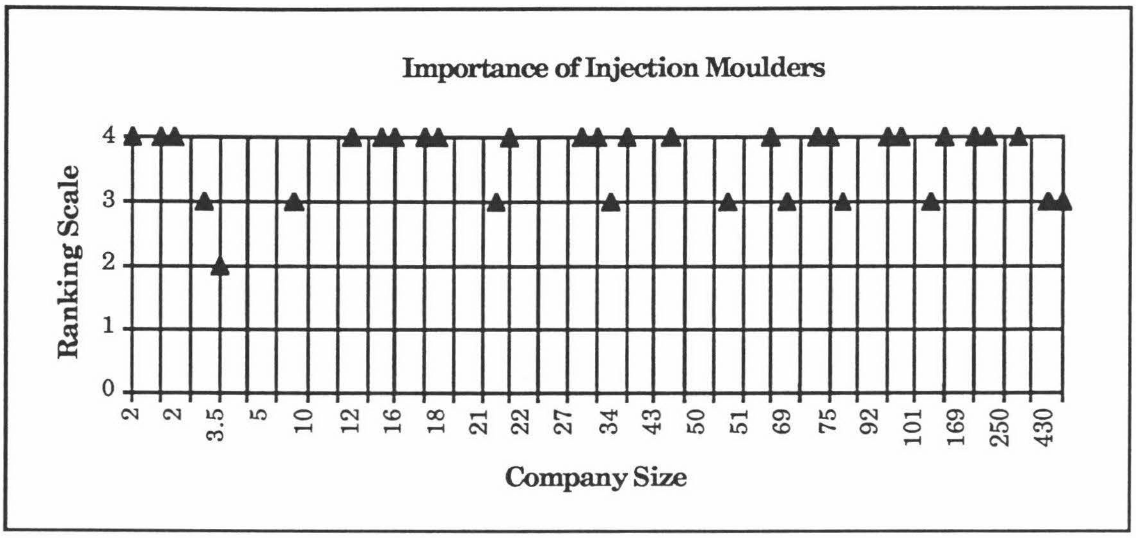


Figure 8.5 (a) Ranking Score Distribution of Importance (Injection)

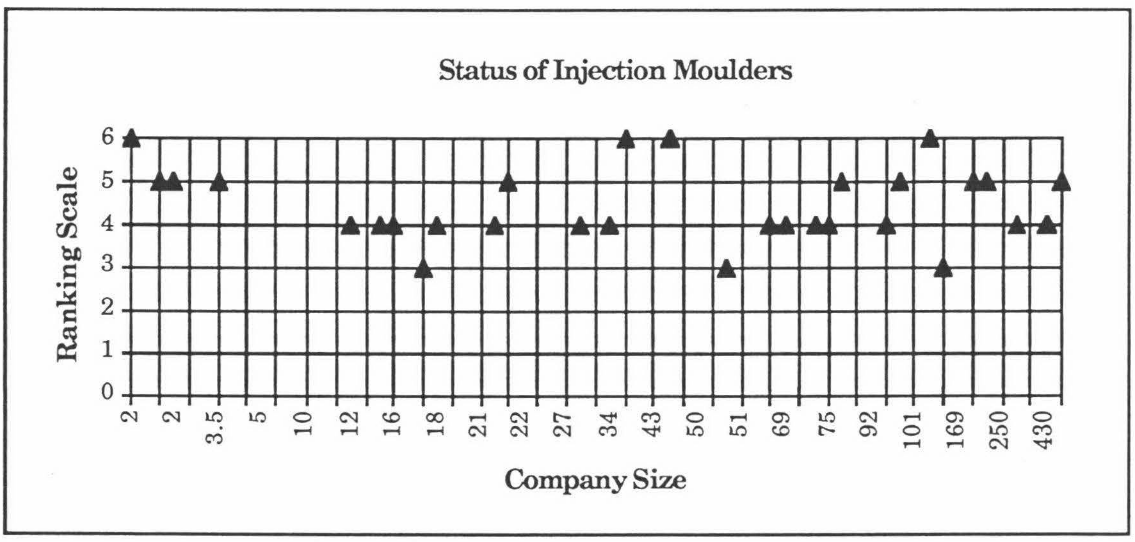


Figure 8.5 (b) Ranking Score Distribution of Status (Injection)

Comments:

Small companies based their high status level of injection moulding on their overseas companies. For the New Zealand environment, it is suggested that only the scores ranked by companies whose size is over 10 should be considered. This restriction is also applied to the data for other technique's status shown in the following figures. Compared with the importance, the company status of injection moulders were evaluated to be of a relatively low standard with only a few companies achieved world leading level. It is noted that this technique is widely distributed in New Zealand plastics companies.

8.4.2 Extruders

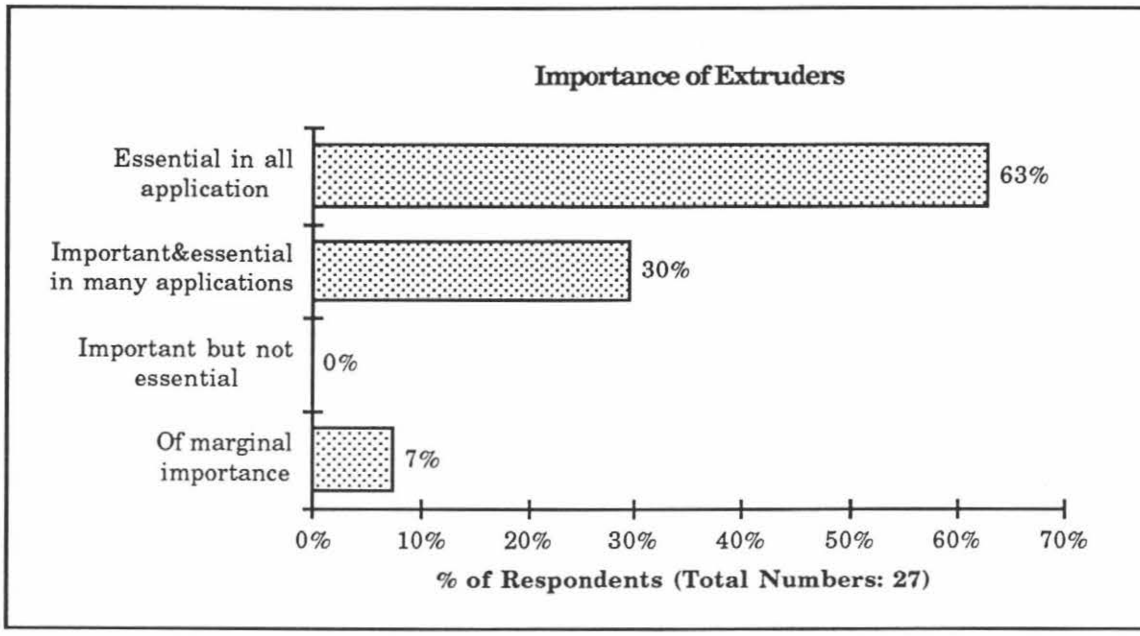


Figure 8.6 (a) Importance of Extruders

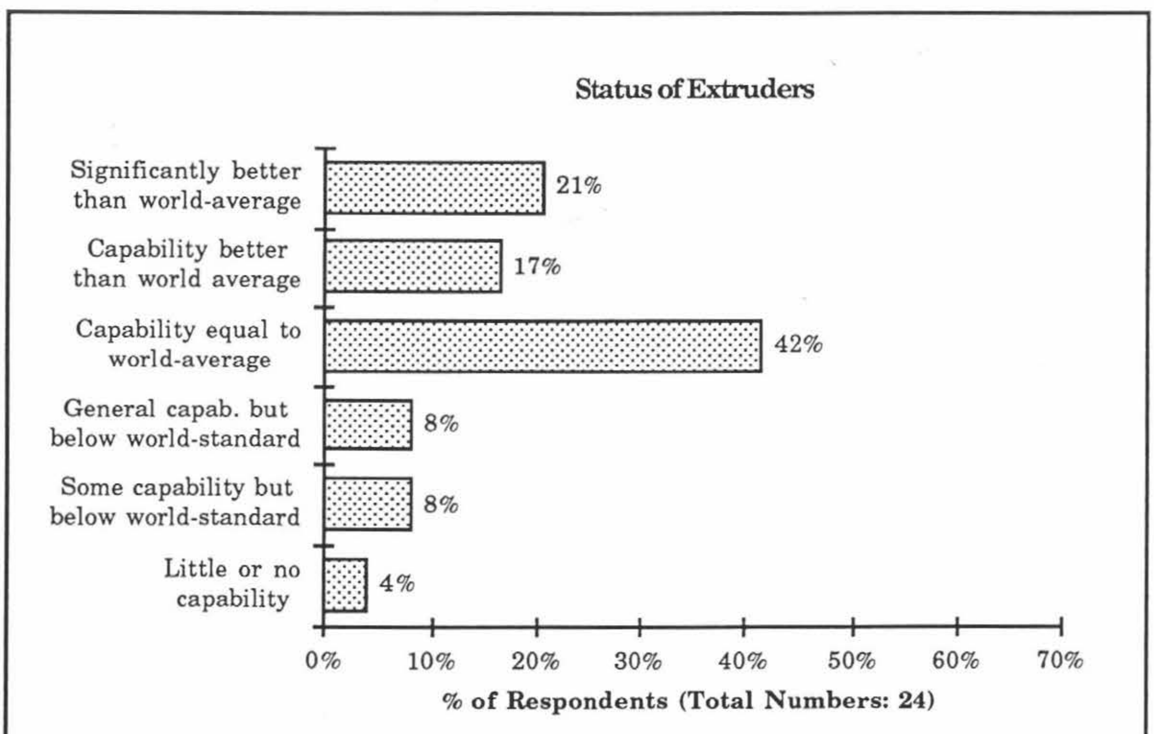


Figure 8.6 (b) Status of Extruders

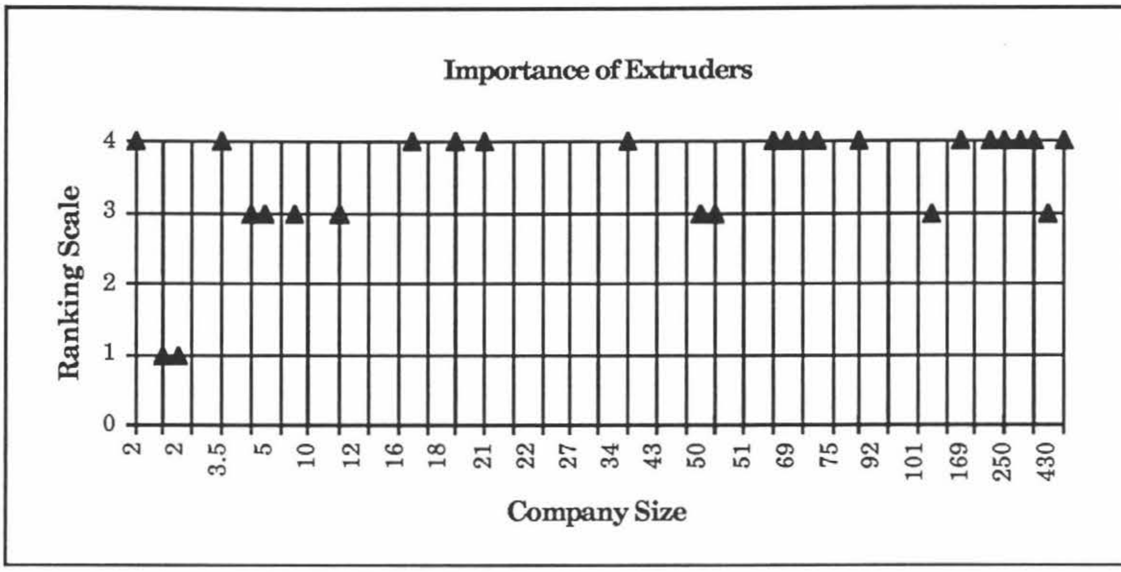


Figure 8.7 (a) Ranking Score Distribution of Importance (Extruders)

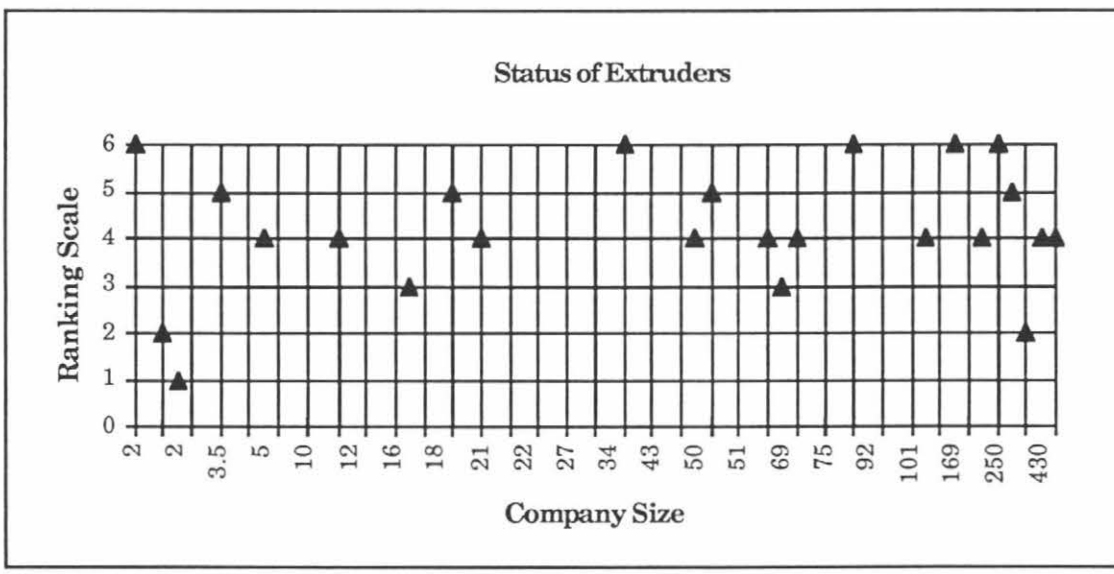


Figure 8.7 (b) Ranking Score Distribution of Status (Extruders)

Comments:

The overall status level of extruders in New Zealand plastics companies is high, but further improvements are still needed because of its importance. Extruding is widely distributed in New Zealand plastics companies and most of large companies have this technique capability with a standard which is relatively better than the world average. Film co-extrusion technique was seen as one of the critical technology changes being likely to be implemented in the New Zealand plastics industry (see Figure 7.3).

8.4.3 Hydraulic Moulding Presses

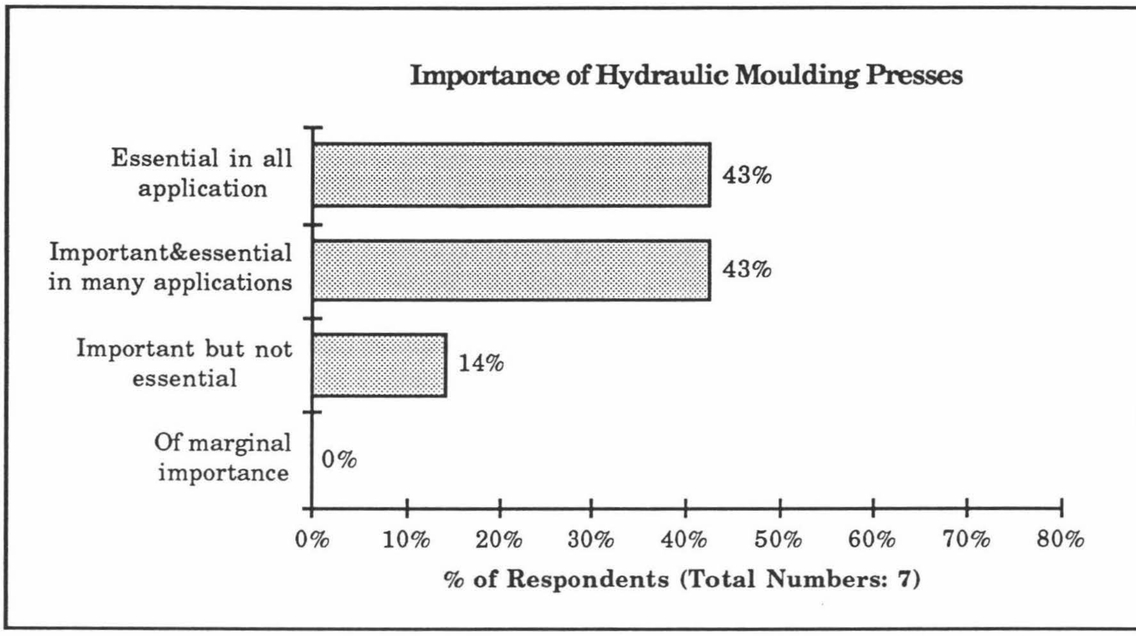


Figure 8.8 (a) Importance of Hydraulic Moulding Presses

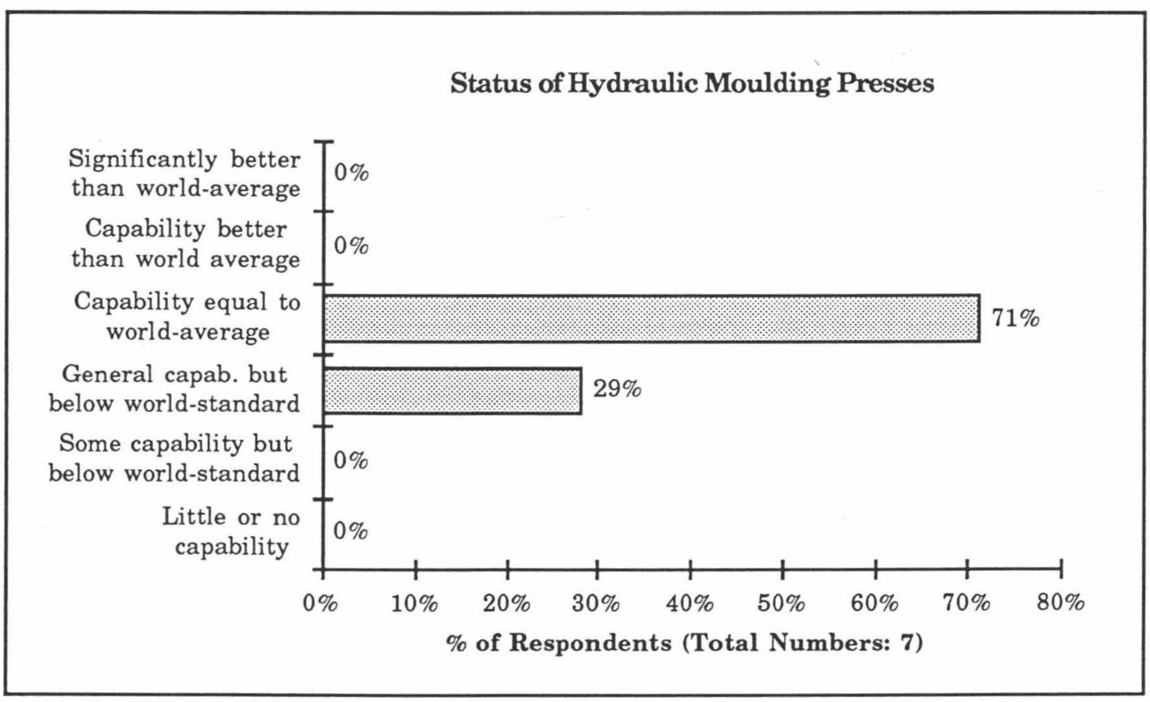


Figure 8.8 (b) Status of Hydraulic Moulding Presses

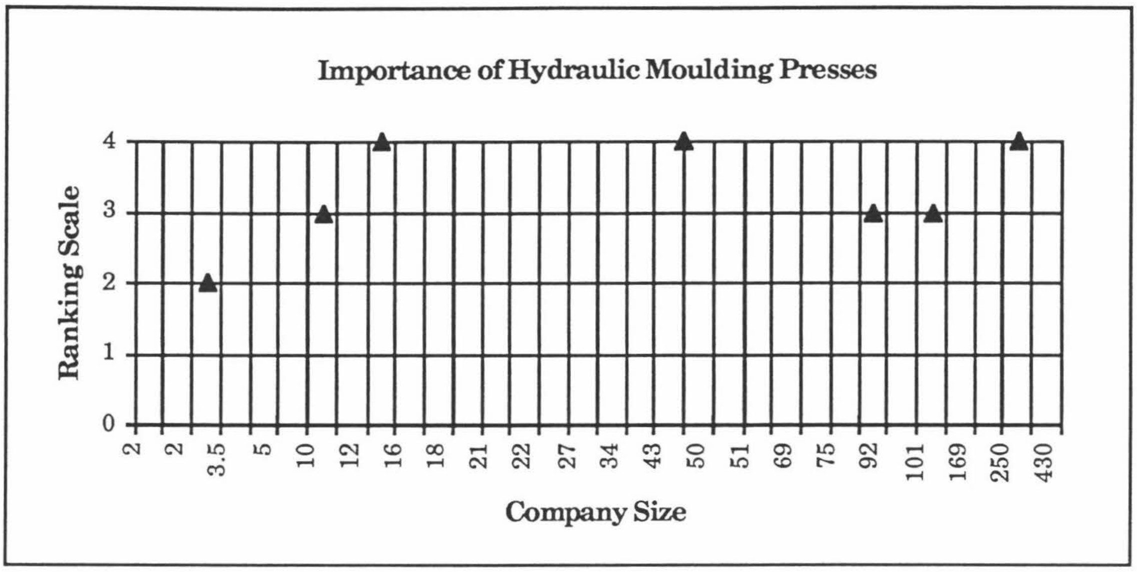


Figure 8.9 (a) Ranking Score Distribution of Importance (Hydraulic Moulding Presses)

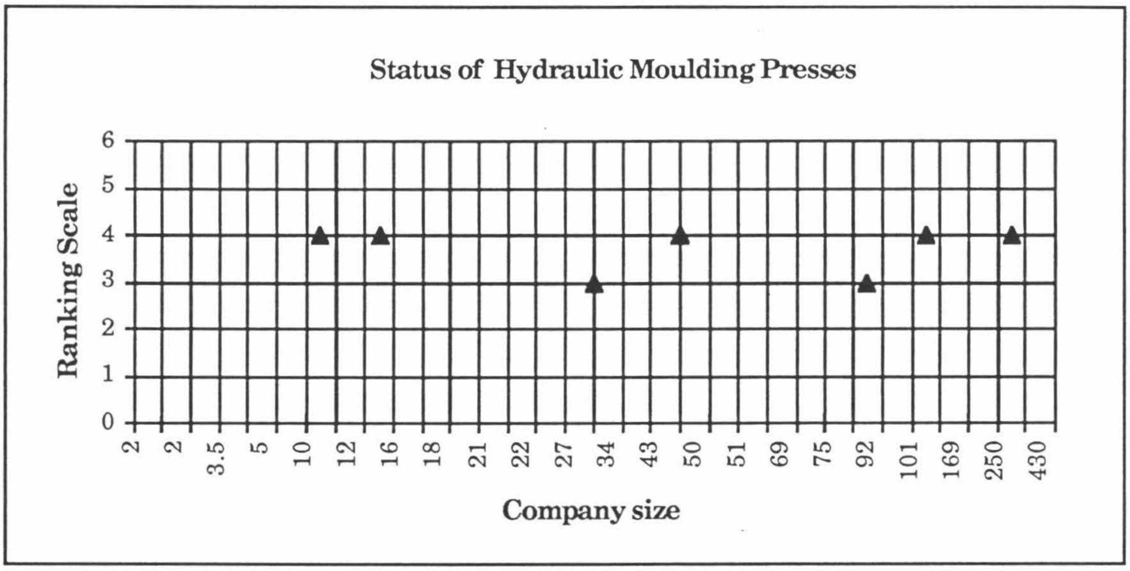


Figure 8.9 (b) Ranking Score Distribution of Status (Hydraulic Moulding Presses)

Comment:

New Zealand plastics companies haven't achieved their capability better than the world status in this technique, but the overall status level (71%) is the same as the world status. It should be noted that the importance of this techniques was seen by most respondents (86%) as essential and important. The further efforts to improve its status are required.

8.4.4 Mixers

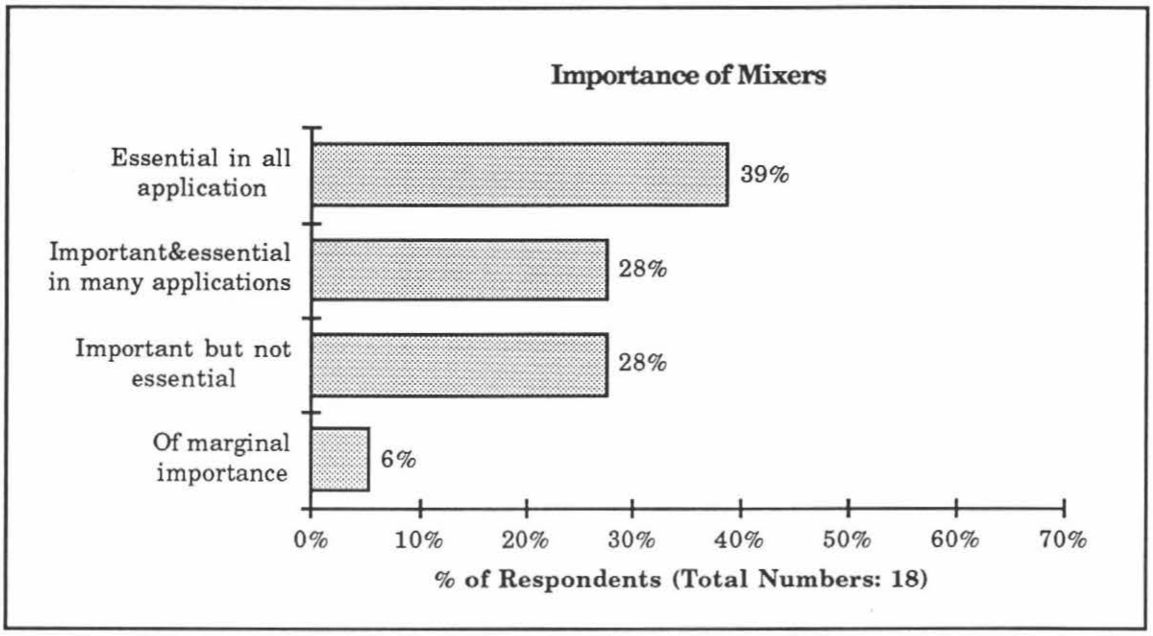


Figure 8.10 (a) Importance of Mixers

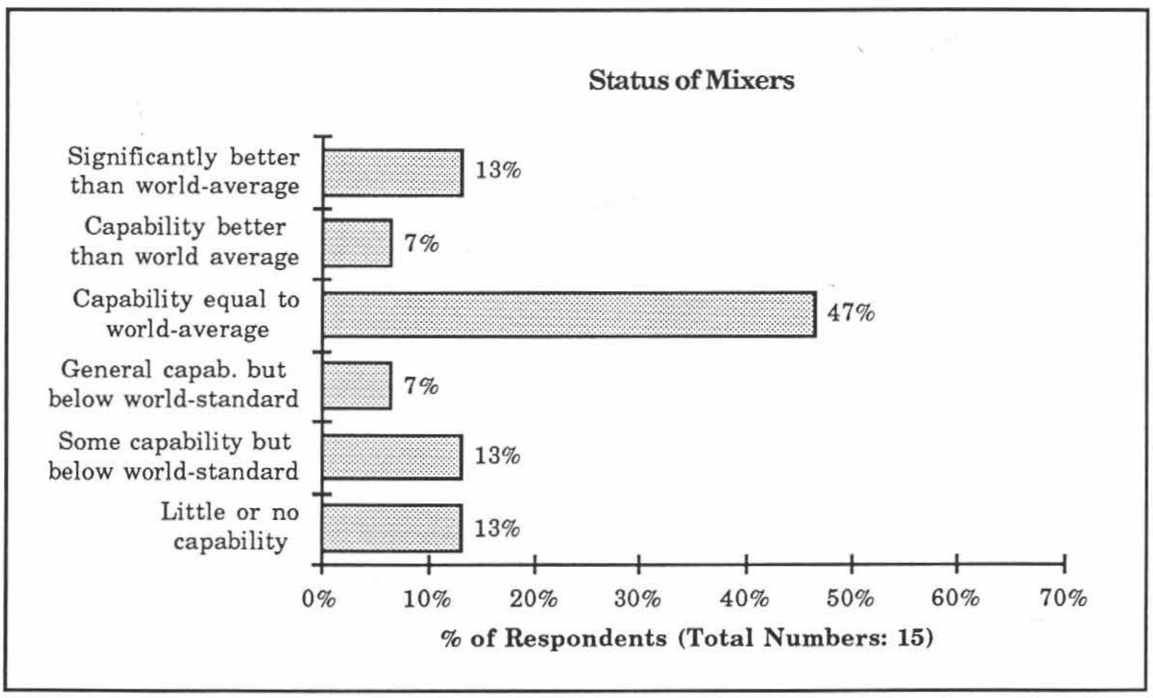


Figure 8.10 (b) Status of Mixers

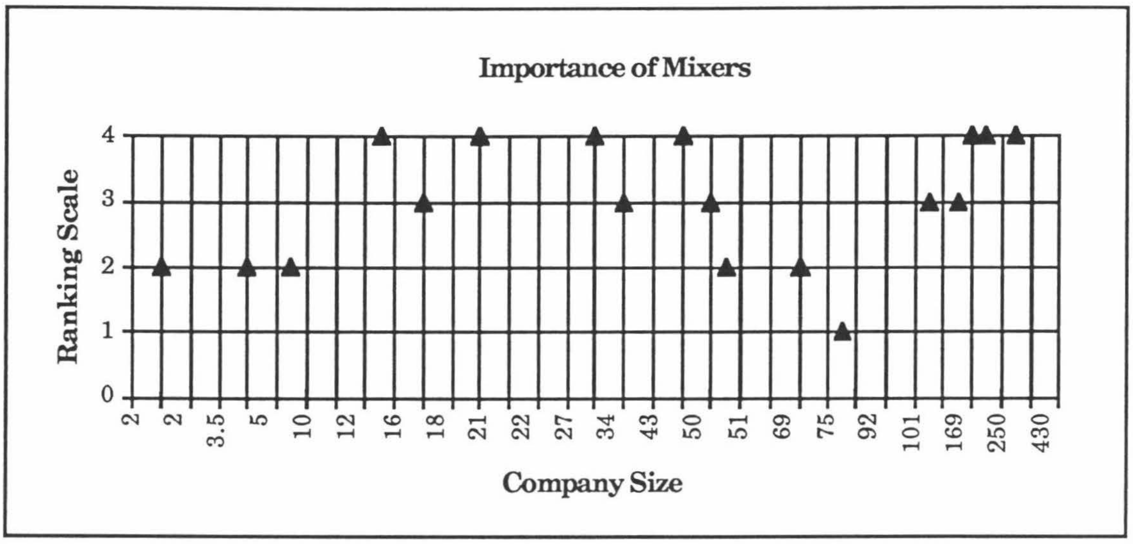


Figure 11 (a) Ranking Score Distribution of Importance (Mixers)

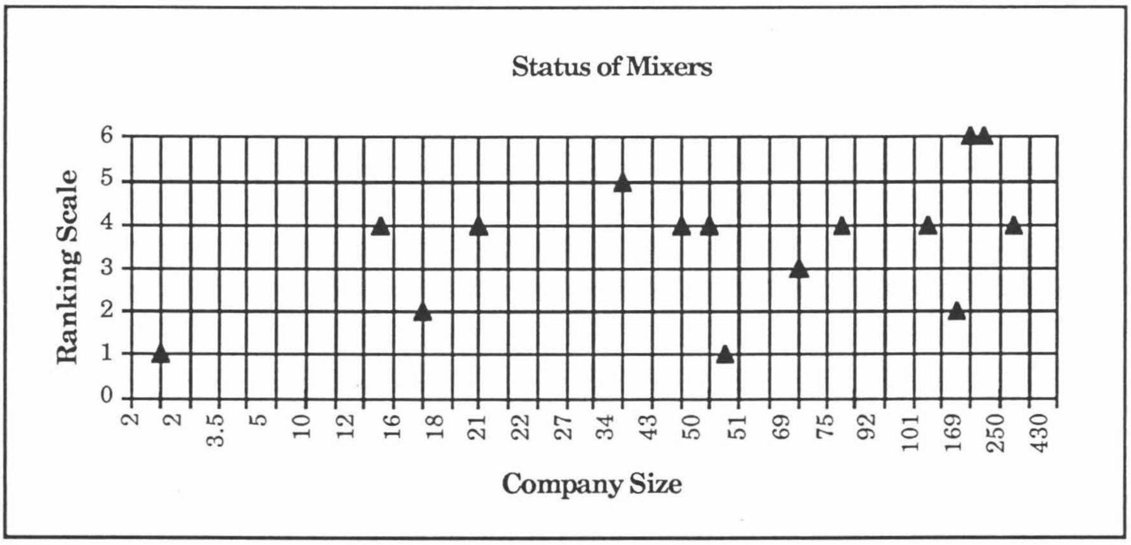


Figure 11 (b) Ranking Score Distribution of Status (Mixers)

Comments:

It should be noted that nearly one third of companies ranked their capability below the world average. The status is low in small and medium companies and high in large companies. Small and medium companies should improve their capability of mixing because the difference between the status and importance is significant.

8.4.5 Laminators

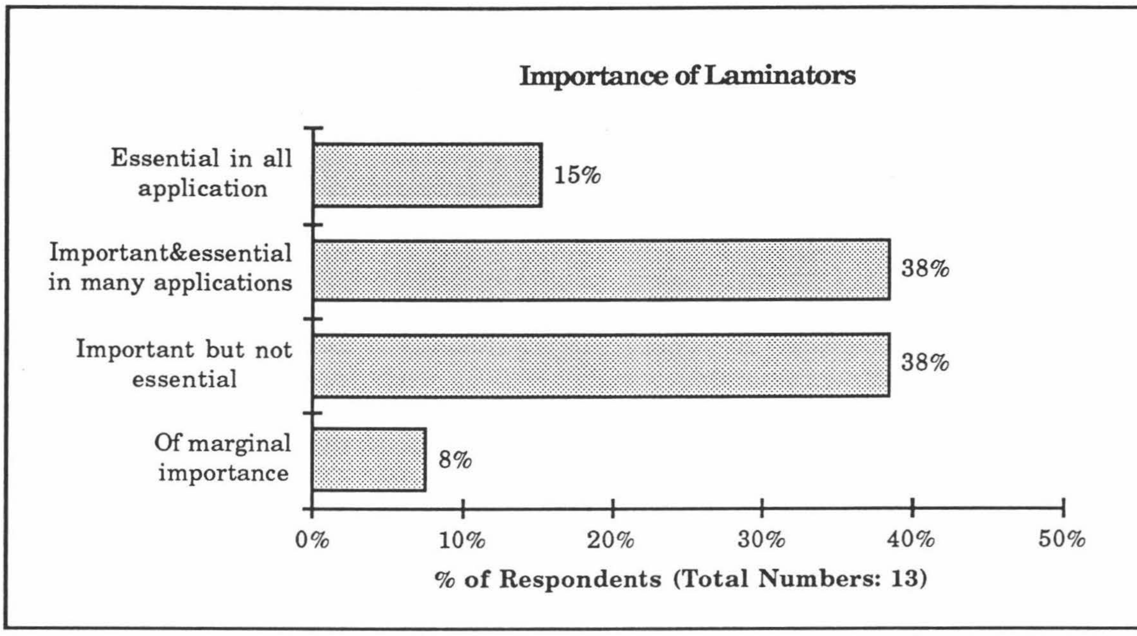


Figure 8.12 (a) Importance of Laminators

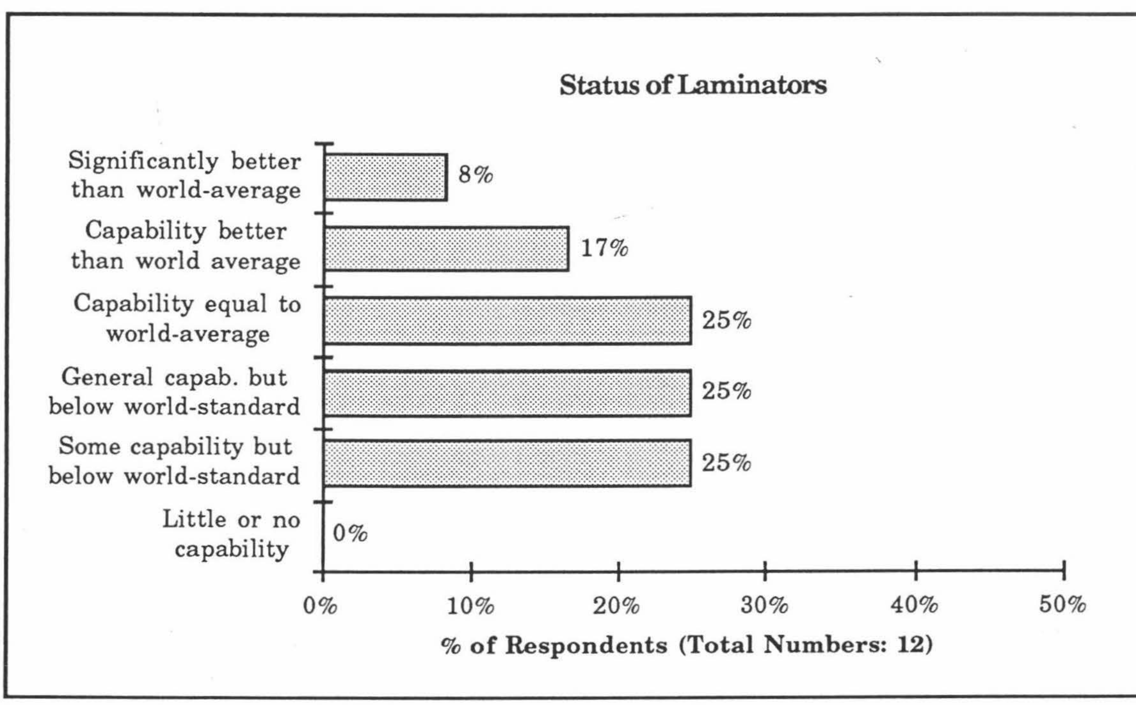


Figure 8.12 (b) Status of Laminators

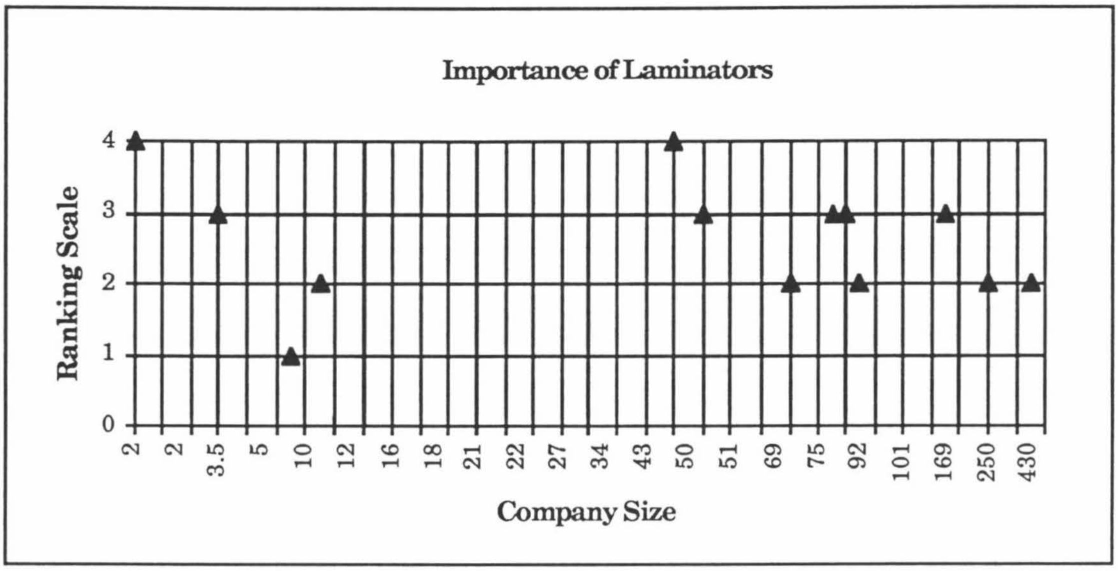


Figure 8.13 (a) Ranking Score Distribution of Importance (Laminator)

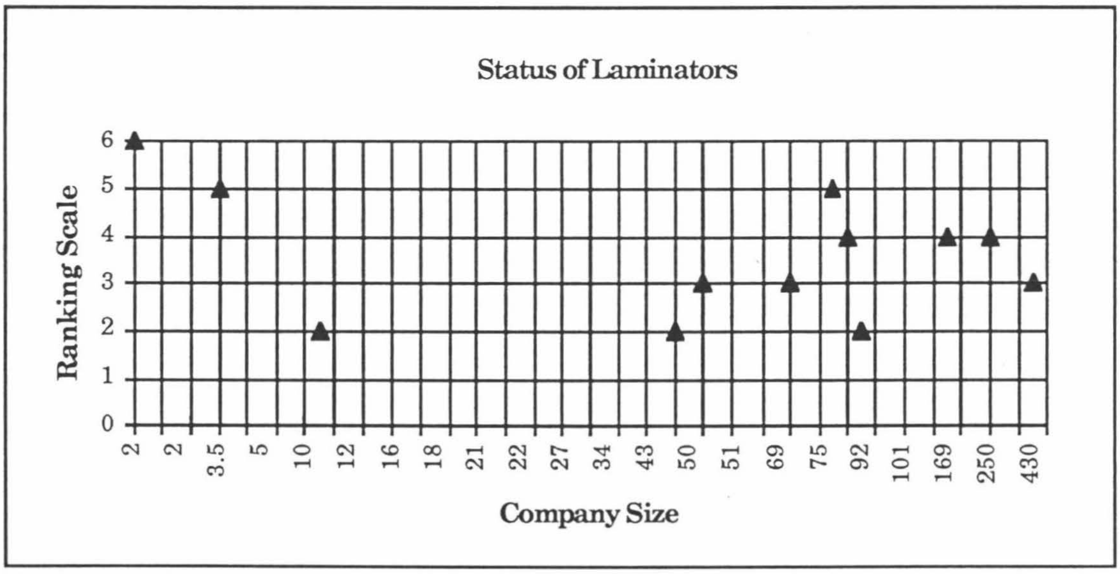


Figure 8.13 (b) Ranking Score Distribution of Status (Laminator)

Comments:

Small companies ranked their status level based on their overseas companies. The technique of laminating is actually located in the companies whose size are over 50, and for them the overall status levels are relatively low. The low status levels can be explained by low importance ranking scores.

8.4.6 Blow Moulders

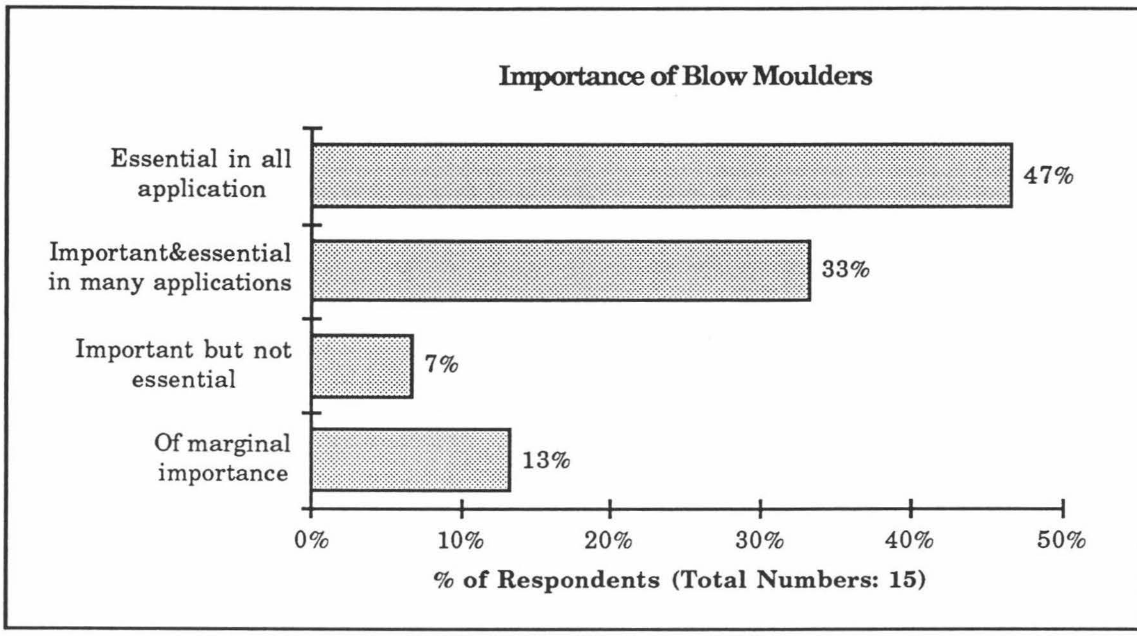


Figure 8.14 (a) Importance of Blow Moulders

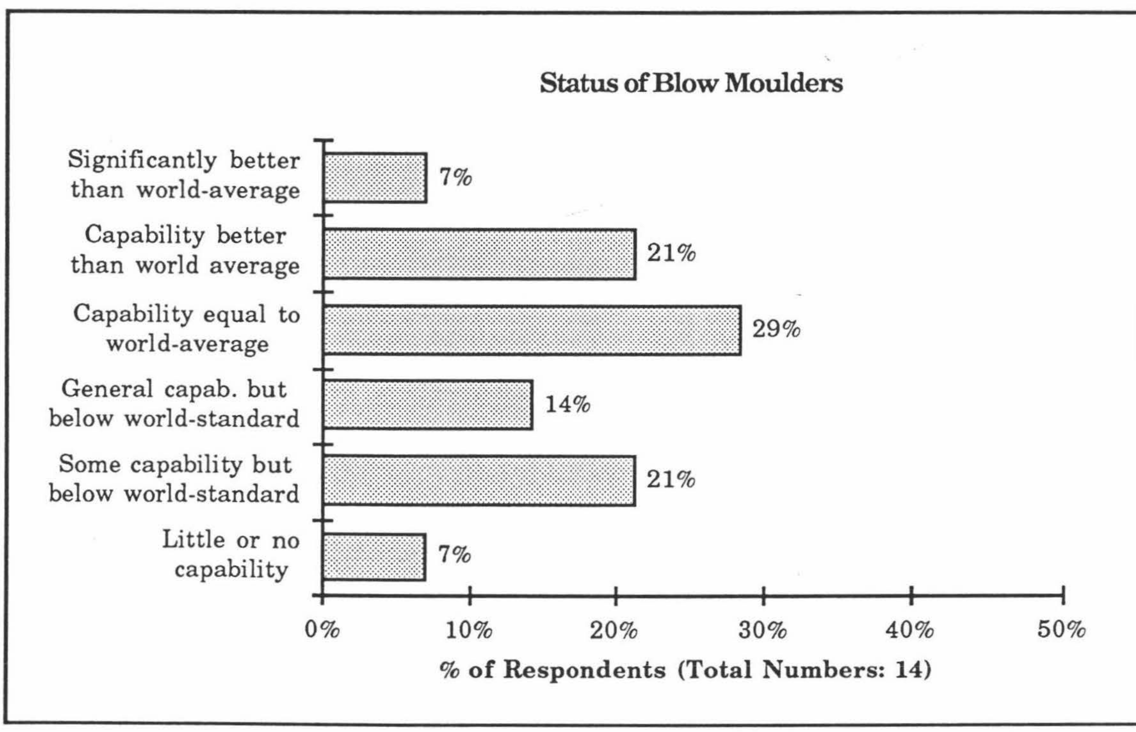


Figure 8.14 (b) Status of Blow Moulders

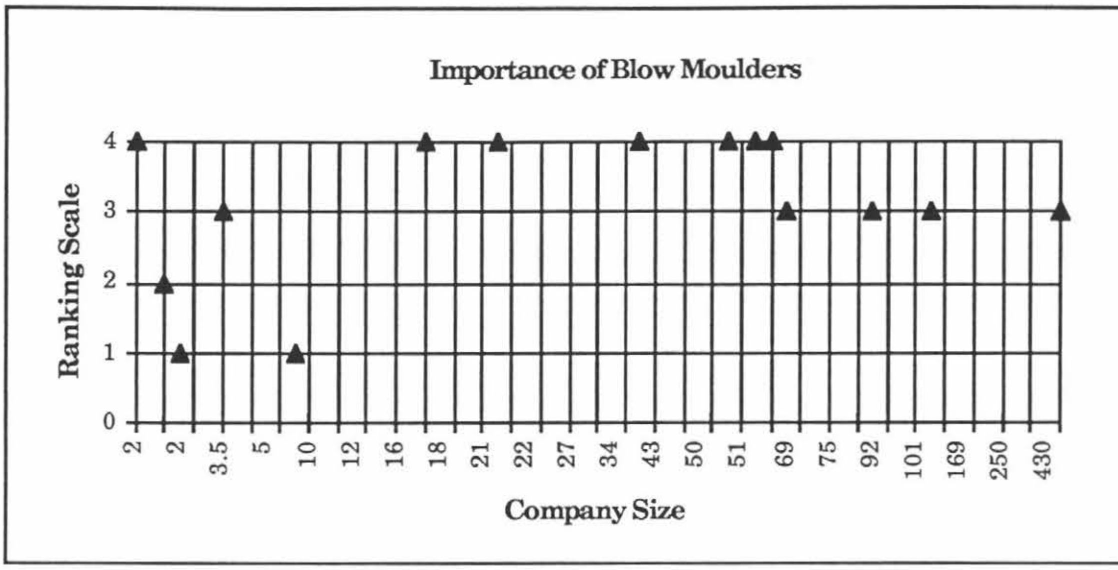


Figure 8.15 (a) Ranking Score Distribution of Importance (Blow Moulders)

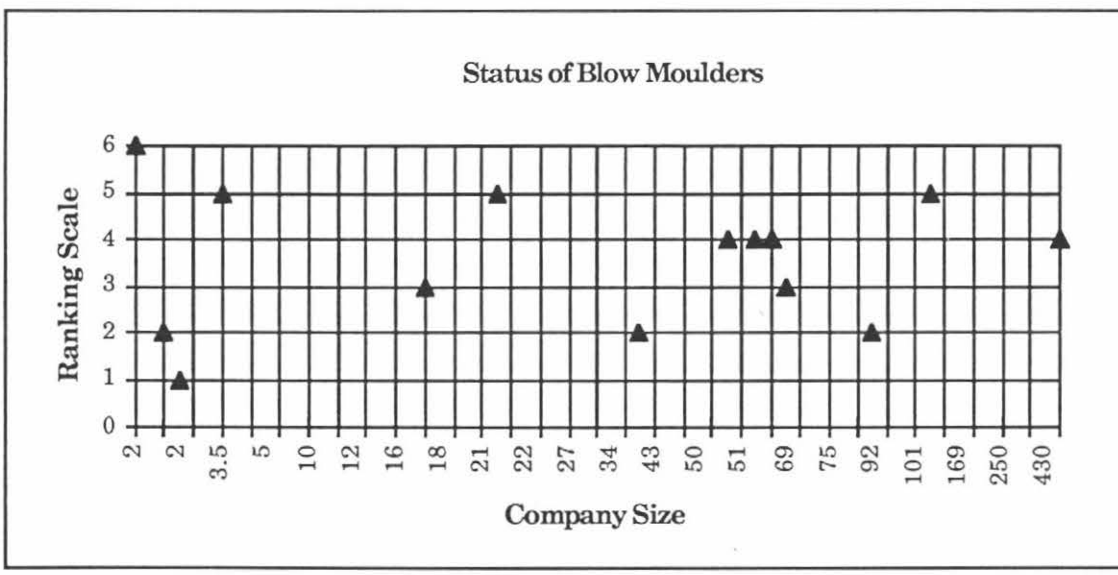


Figure 8.15 (b) Ranking Score Distribution of Status (Blow Moulders)

Comments:

Except for one small company which is based on its overseas parent, no company has achieved a capability significantly better than world standard. The techniques of blow moulders are widely used in companies no matter what the size they are, but overall status level was lower than desired. For medium companies, the difference between importance and status is apparent.

8.4.7 Grinders

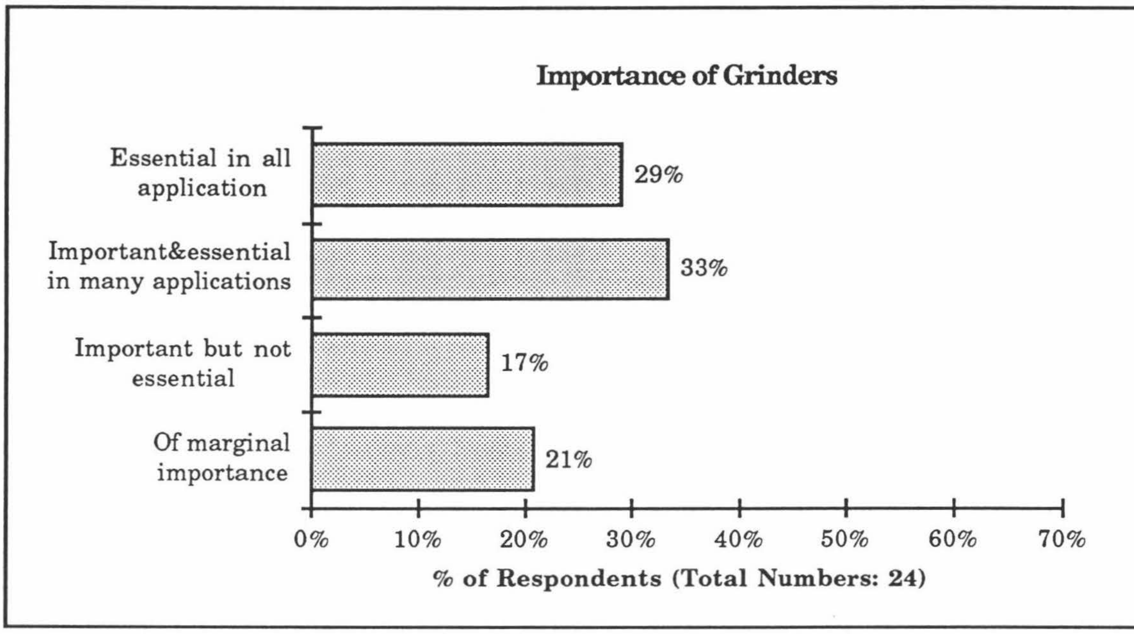


Figure 8.16 (a) Importance of Grinders

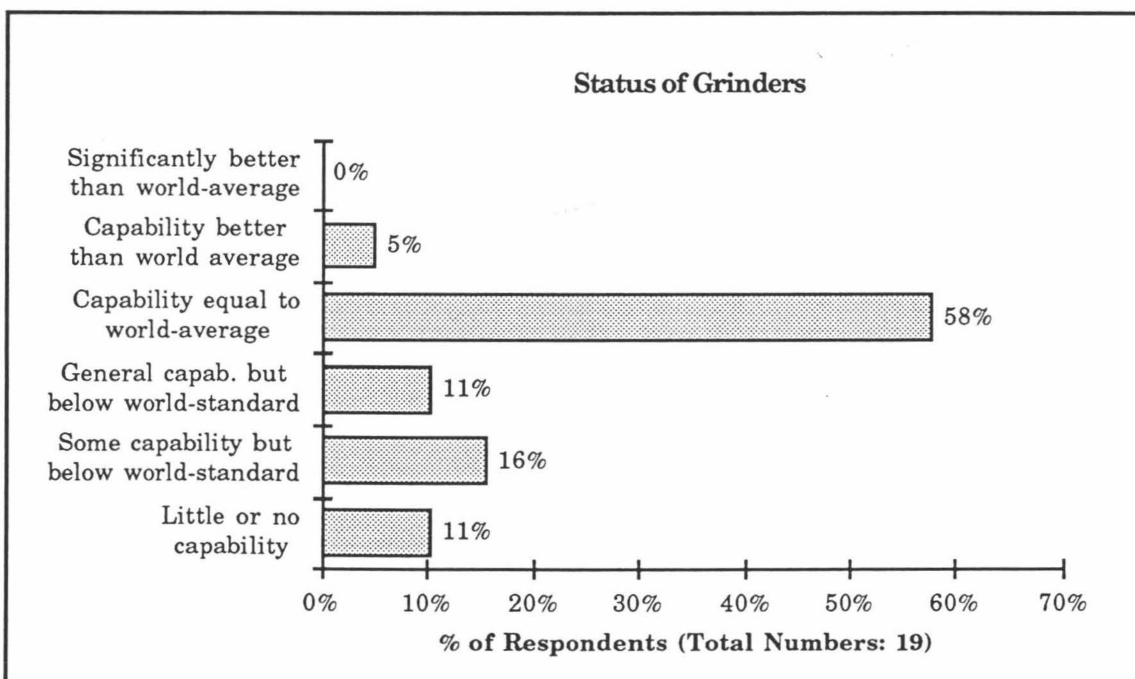


Figure 8.16 (b) Status of Grinders

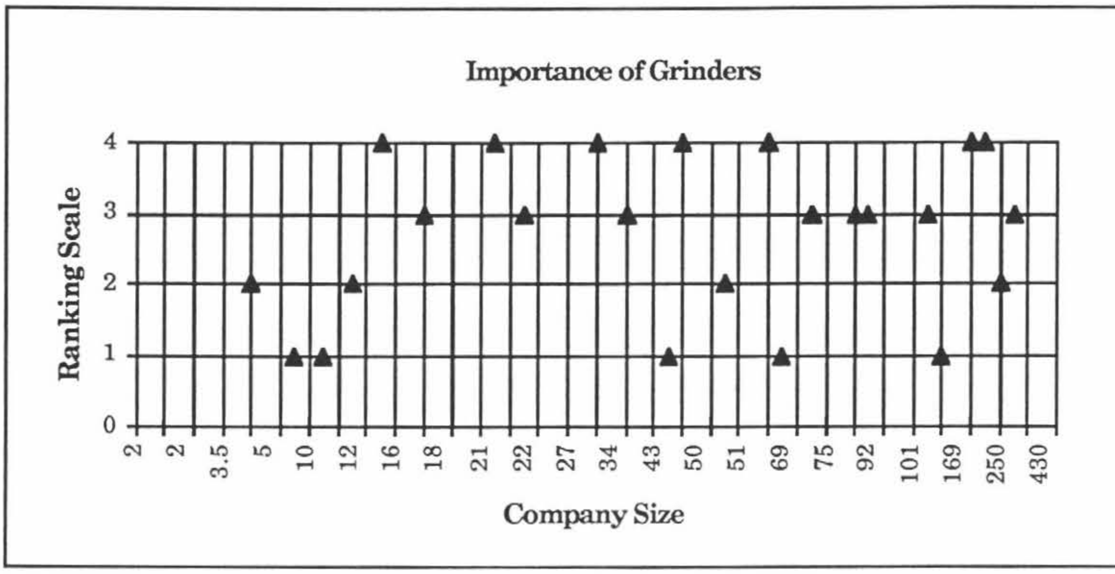


Figure 8.17 (a) Ranking Score Distribution of Importance (Grinders)

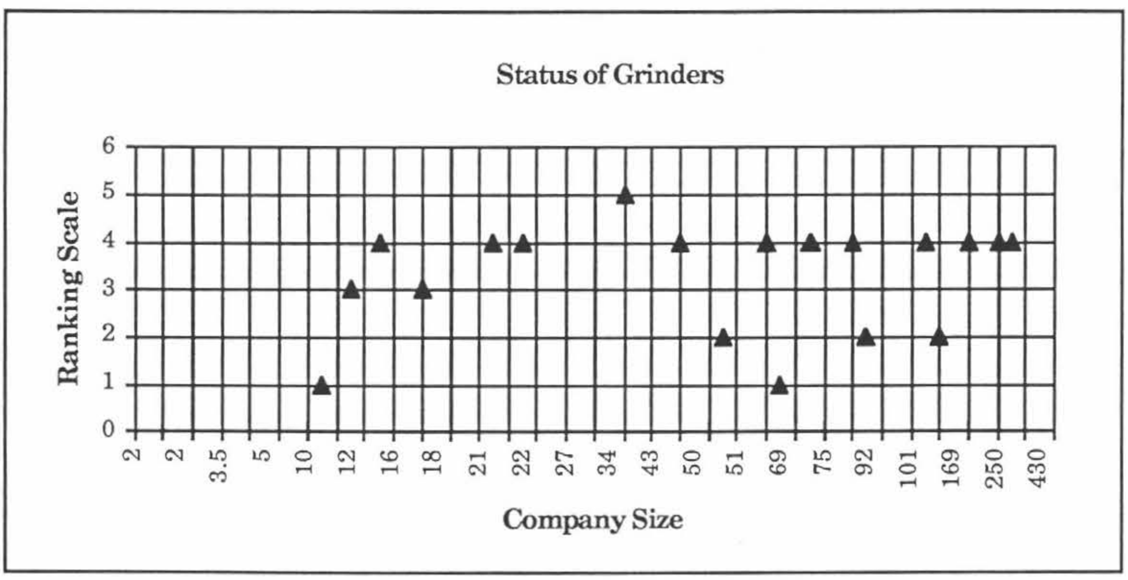


Figure 8.17 (b) Ranking Score Distribution of Status (Grinders)

Comments:

This technique has been widely used in New Zealand plastics companies. However, some companies had a very low capability in this area, perhaps because some companies haven't given more emphasis on the importance of this technique. Further investigation into causes for this low capability is needed.

8.4.8 Flexible Manufacturing Systems (FMS)

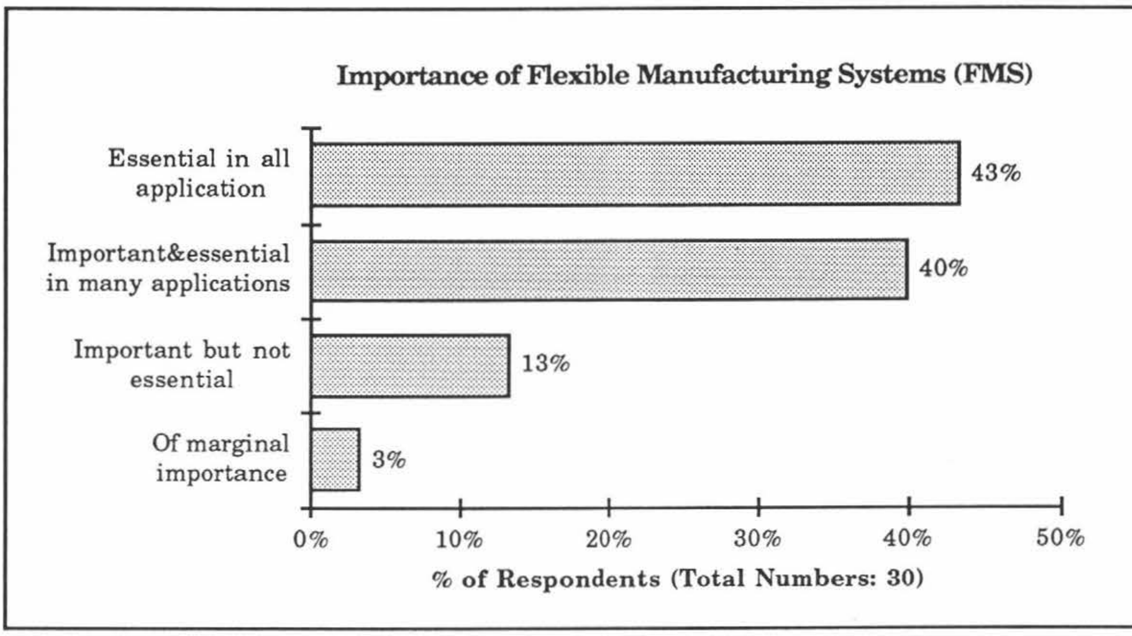


Figure 8.18 (a) Importance of FMS

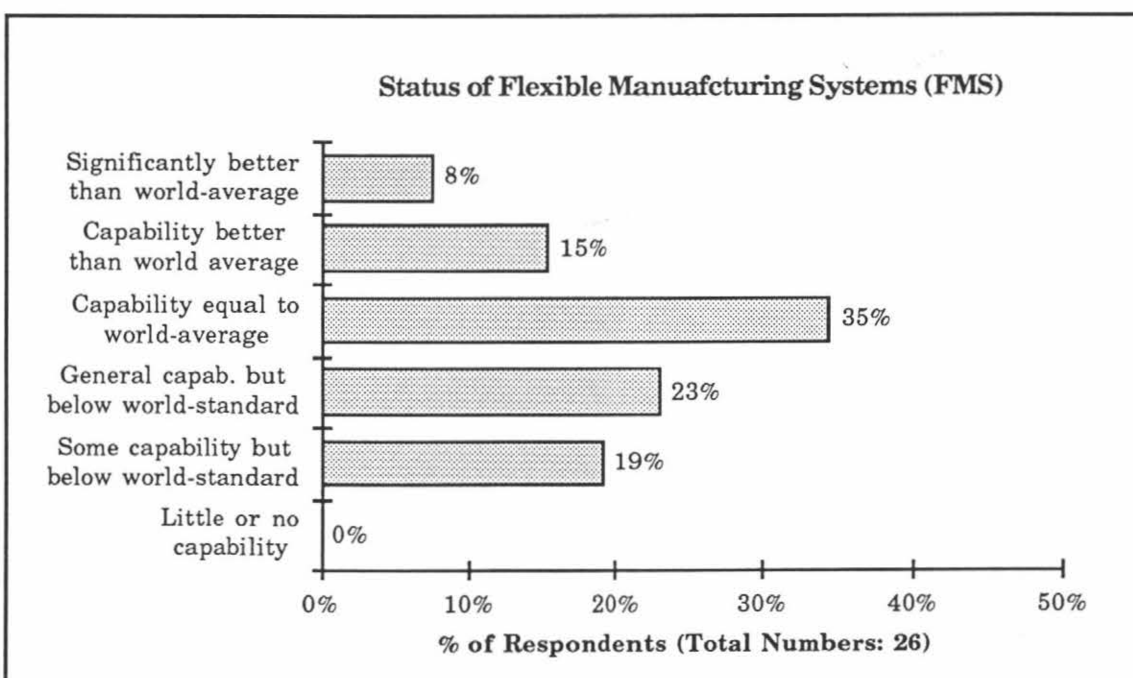


Figure 8.18 (b) Status of FMS

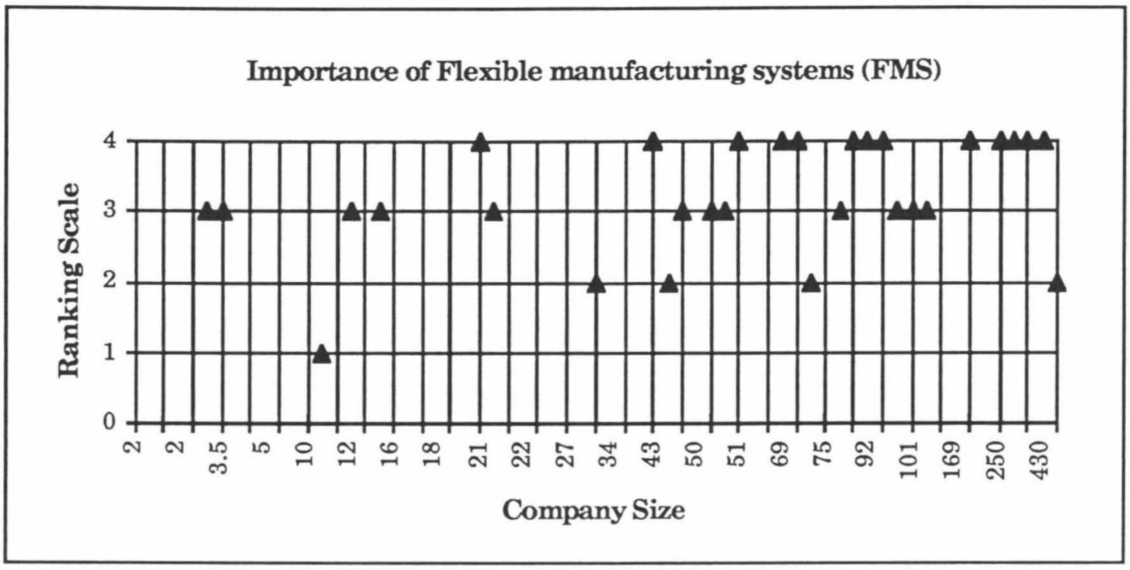


Figure 8.19 (a) Ranking Score Distribution of Importance (FMS)

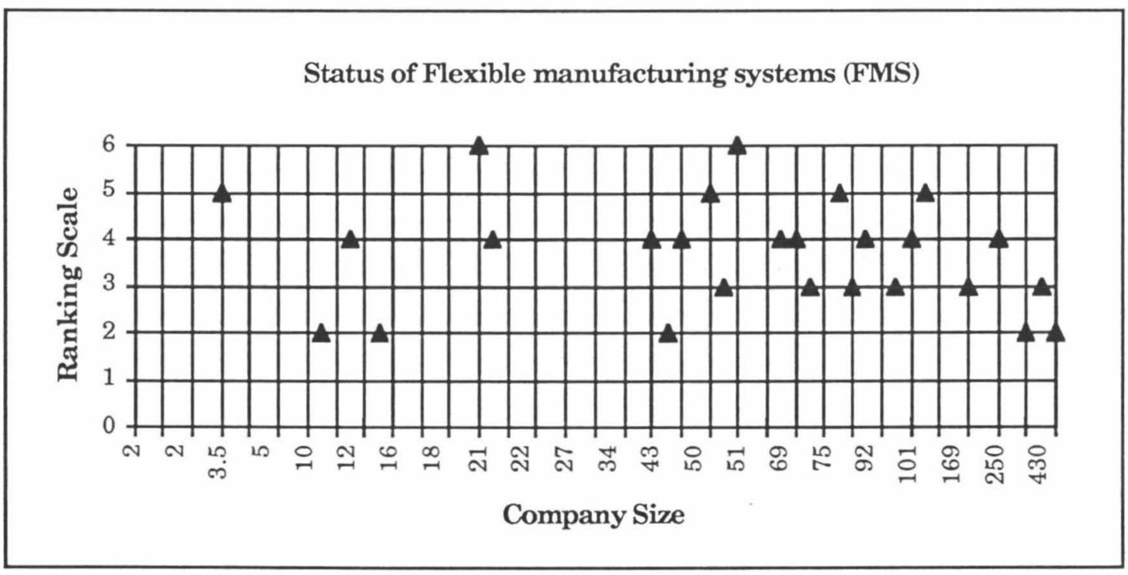


Figure 8.19 (b) Ranking Score Distribution of Status (FMS)

Comments:

Flexible manufacturing systems (FMS) has been widely used in medium and large companies, but the further improvements are still needed since some companies ranked its importance with the highest scores.

8.4.9 Robots and Automation

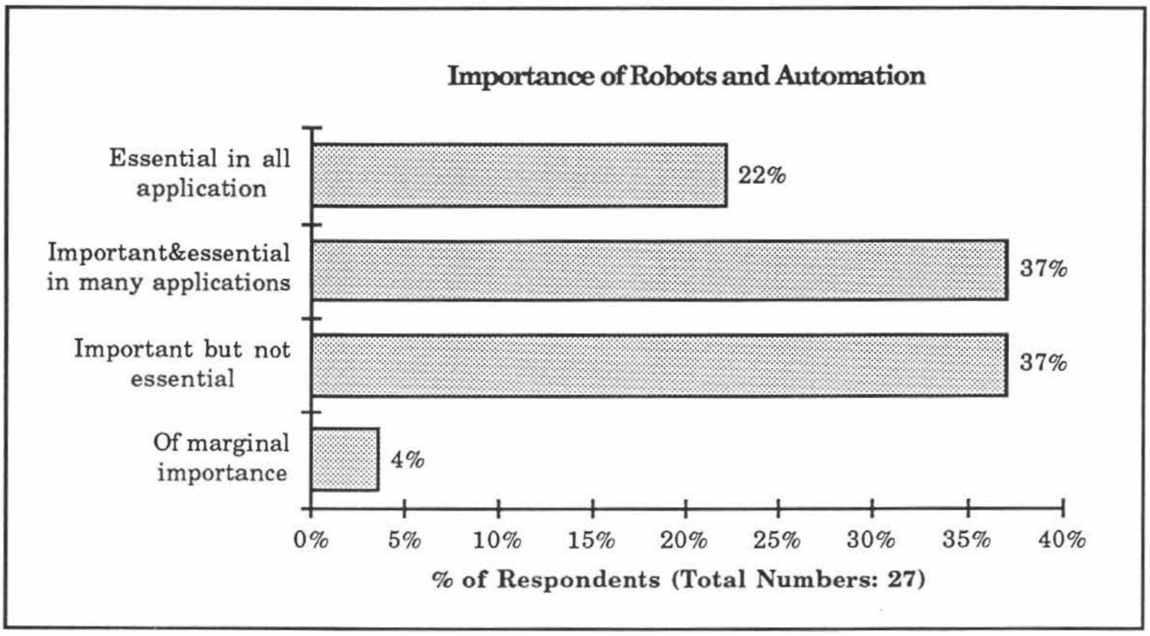


Figure 8.20 (a) Importance of Robots and Automation

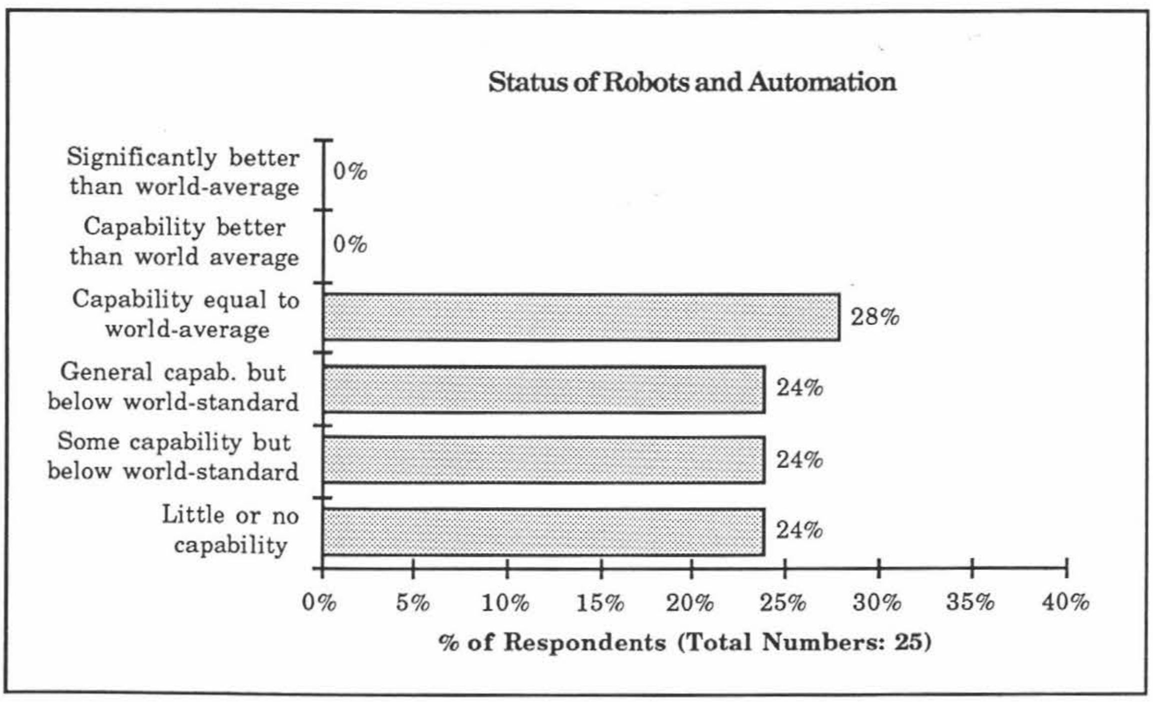


Figure 8.20 (b) Status of Robots and Automation

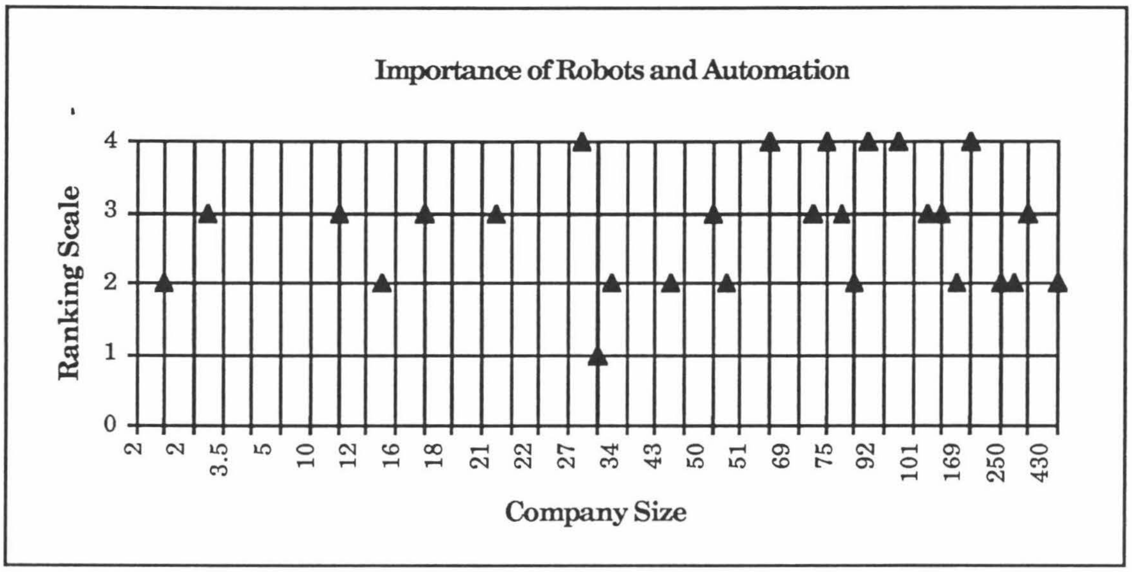


Figure 8.21 (a) Ranking Score Distribution of Importance Robots and Automation

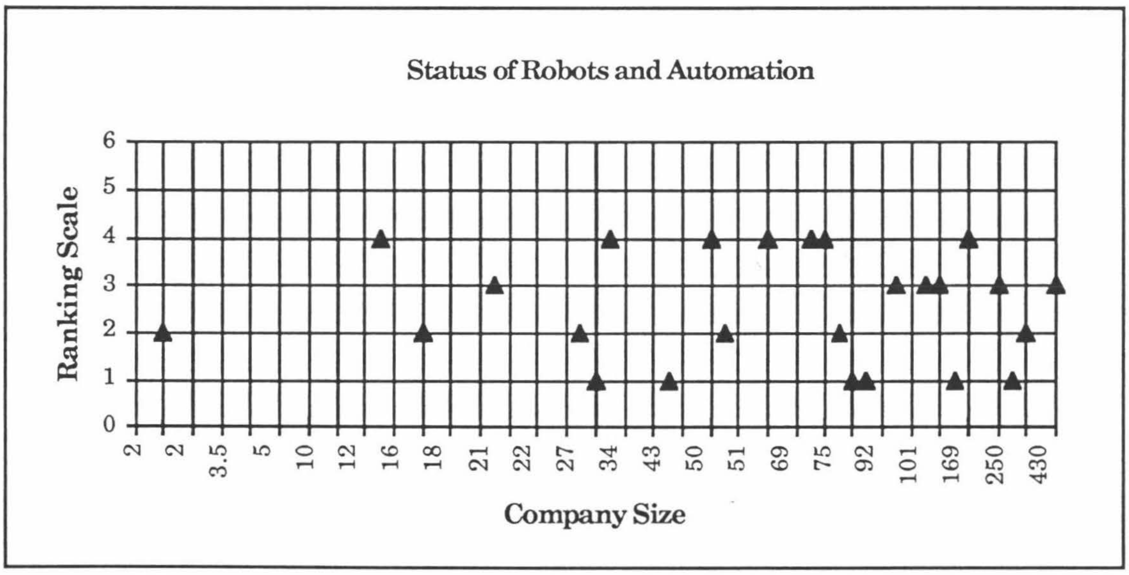


Figure 8.21 (b) Ranking Score Distribution of Status Robots and Automation

Comments:

Although this technique has been widely used in the New Zealand plastics industry, the overall status level was low compared with its importance ranking scores. As robots and automation was seen by the respondents as one of the critical technology changes (see Figure 7.3), the improvement in this technique could be seen to be urgent.

8.4.10 Computer Aided Design (CAD)

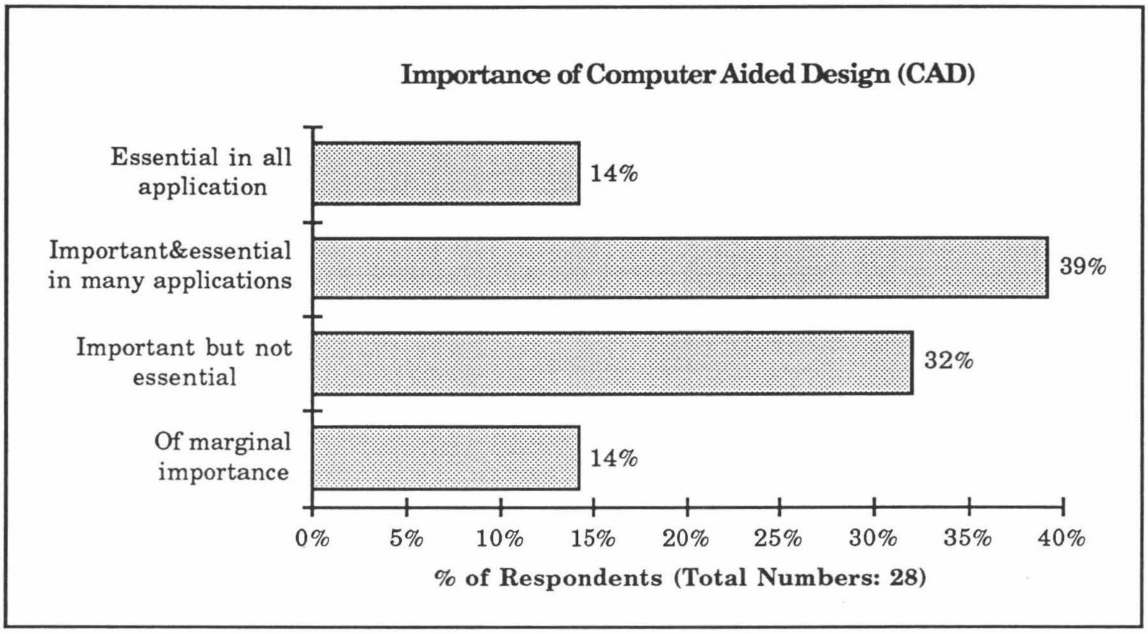


Figure 8.22 (a) Importance of CAD

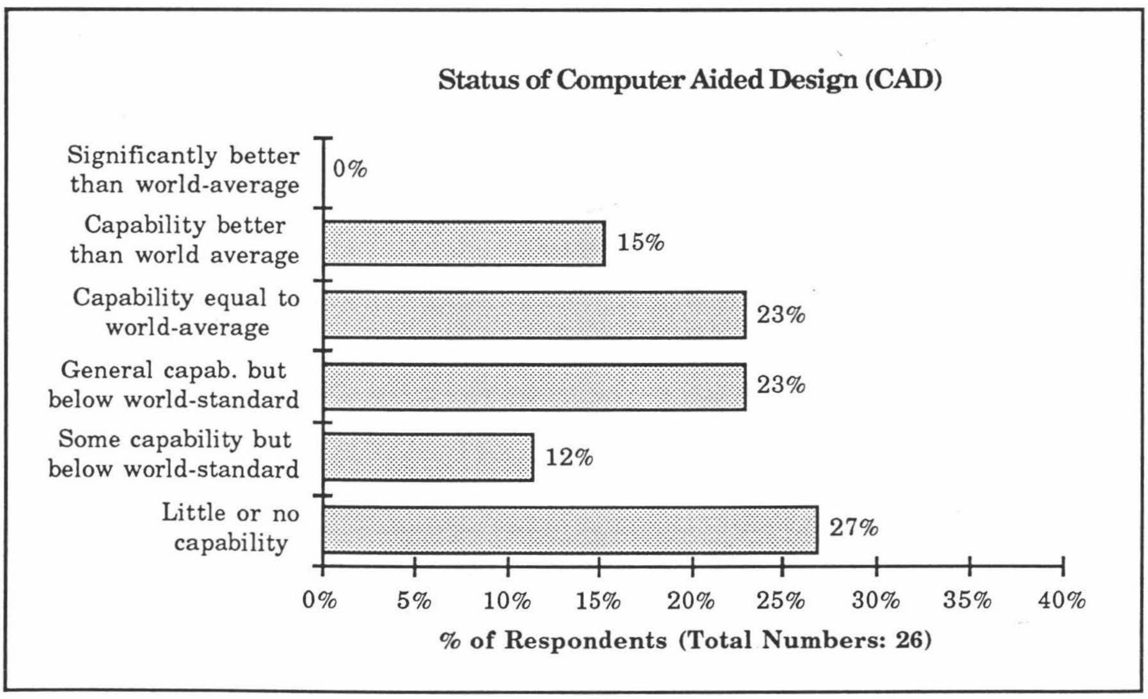


Figure 8.22 (b) Status of CAD

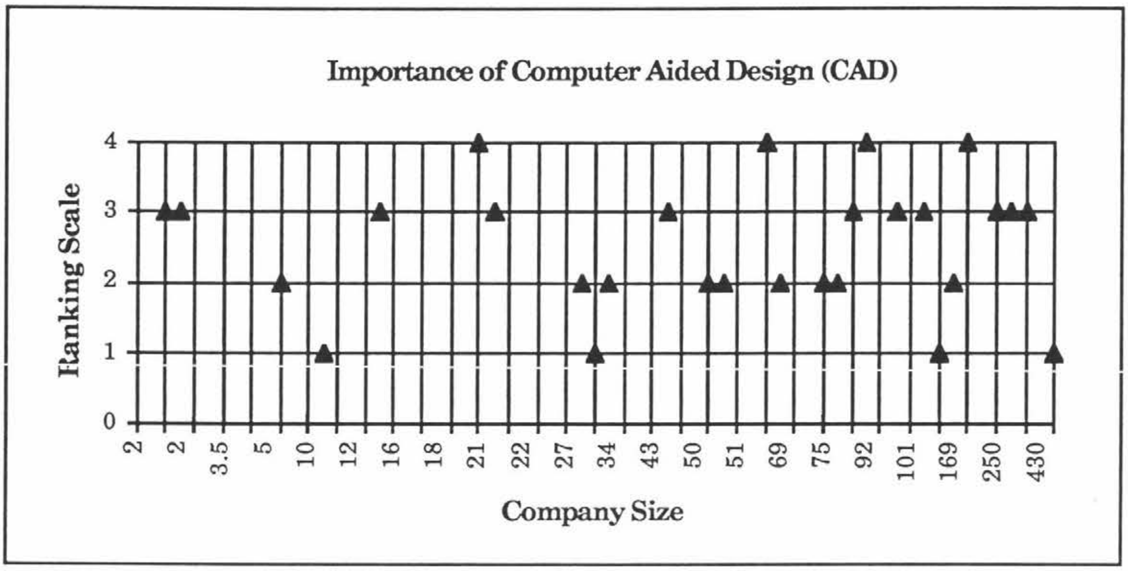


Figure 2.23 (a) Ranking Score Distribution of Importance (CAD)

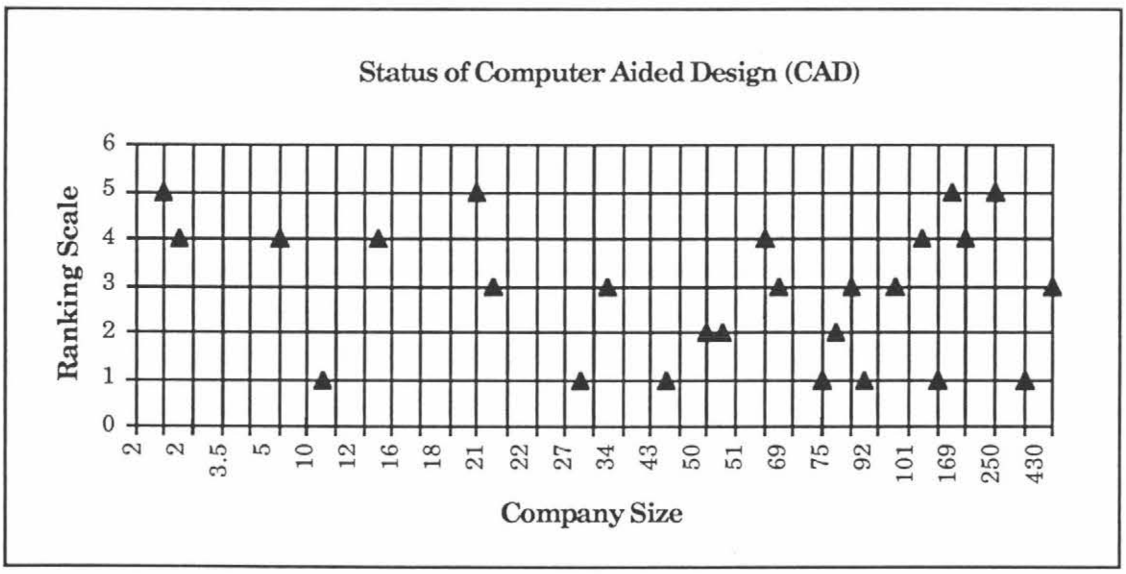


Figure 2.23 (b) Ranking Score Distribution of Status (CAD)

Comments:

Both importance and status were wide spread. The overall status level of CAD was low, especially in medium size companies (size between 30 an 100), and the importance was also ranked with relatively low scores by some companies.

8.4.11 Computer Aided Manufacturing (CAM)

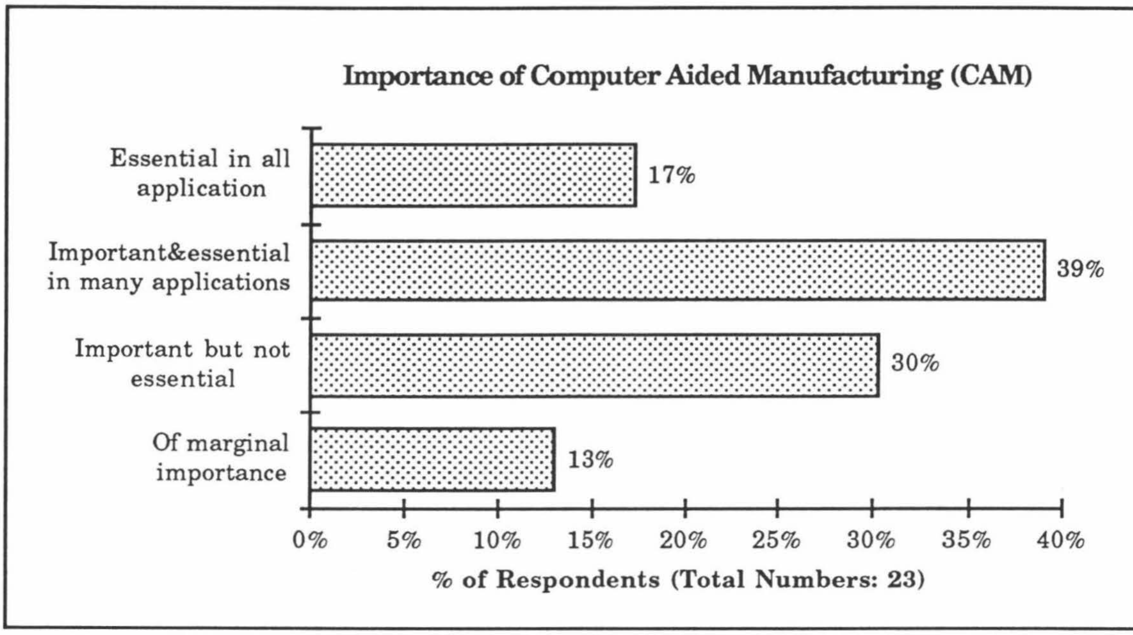


Figure 8.24 (a) Importance of CAM

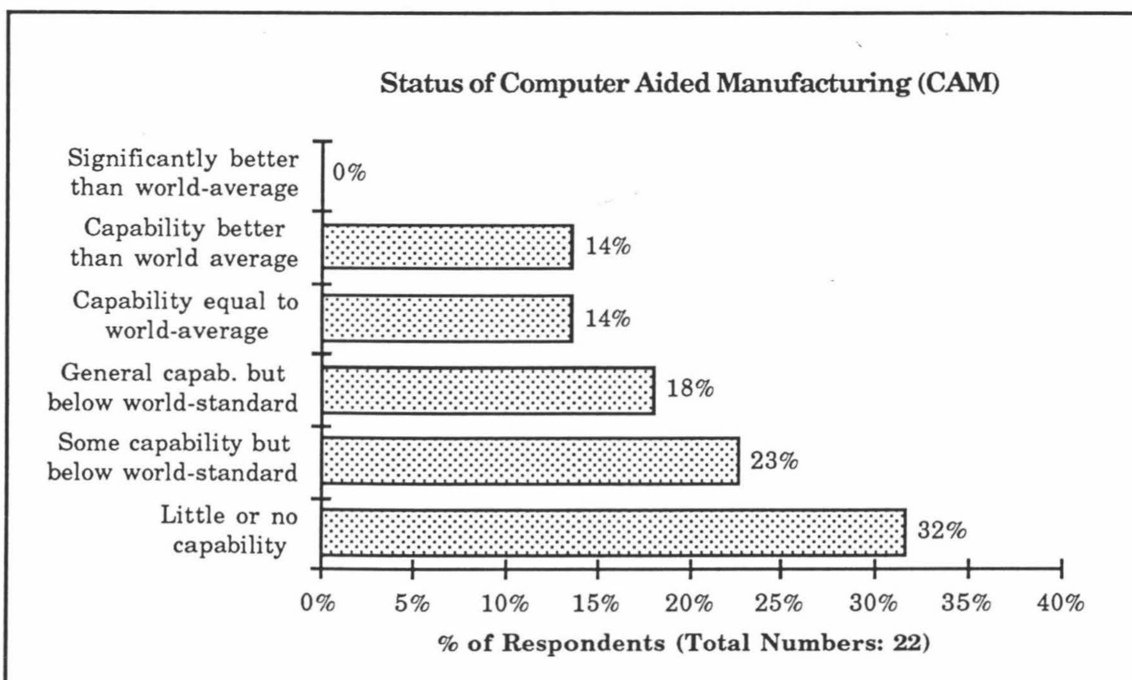


Figure 8.24 (b) Status of CAM

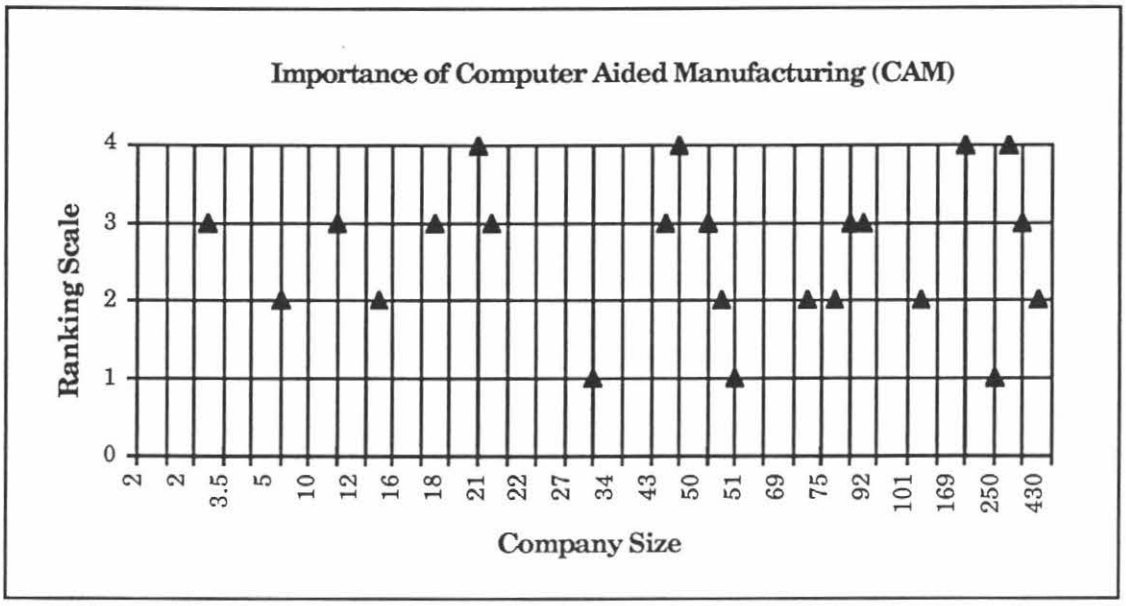


Figure 8.25 (a) Ranking Score Distribution of Importance (CAM)

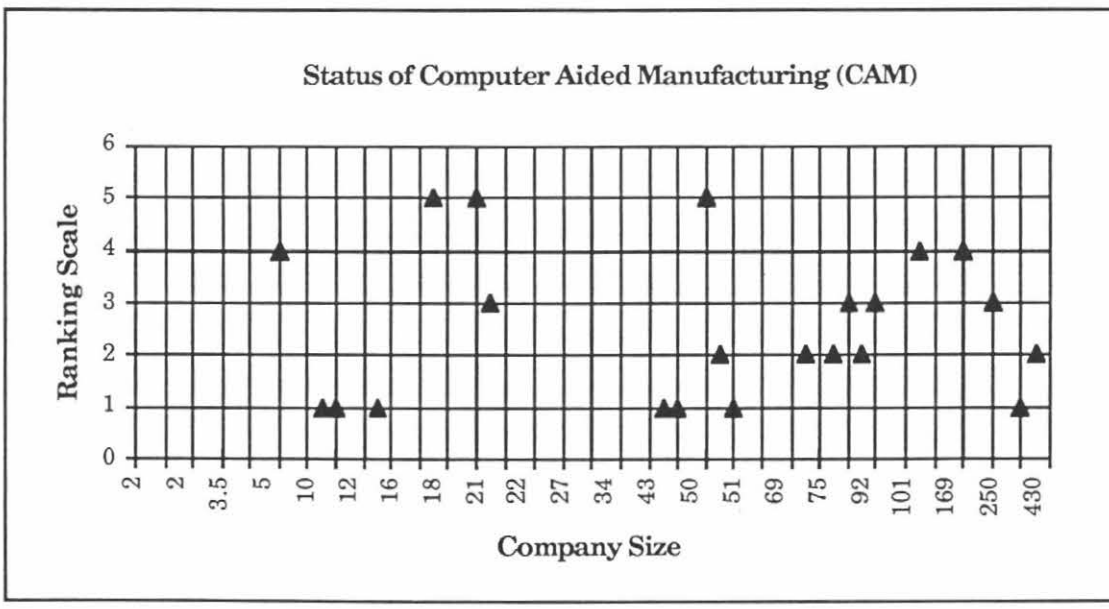


Figure 8.25 (b) Ranking Score Distribution of Status (CAM)

Comments:

It was found that one third of the companies had little or no capability in this technique. As the importance of computer aided manufacturing was ranked relatively high, further study is suggested .

8.4.12 Computer Integrated Manufacturing (CIM)

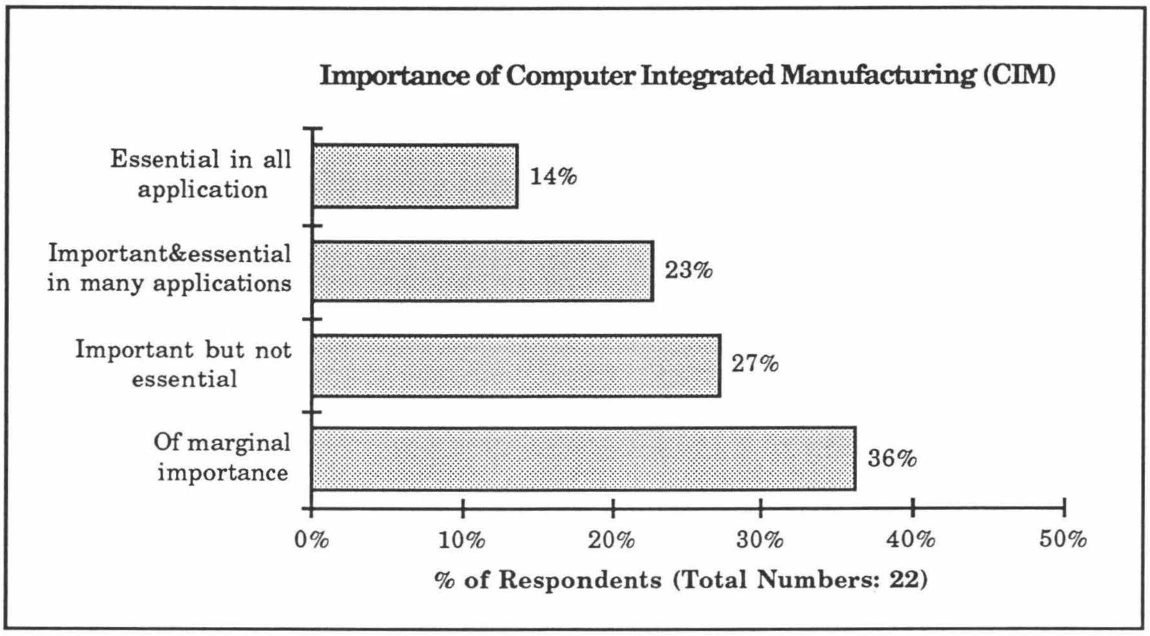


Figure 8.26 (a) Importance of CIM

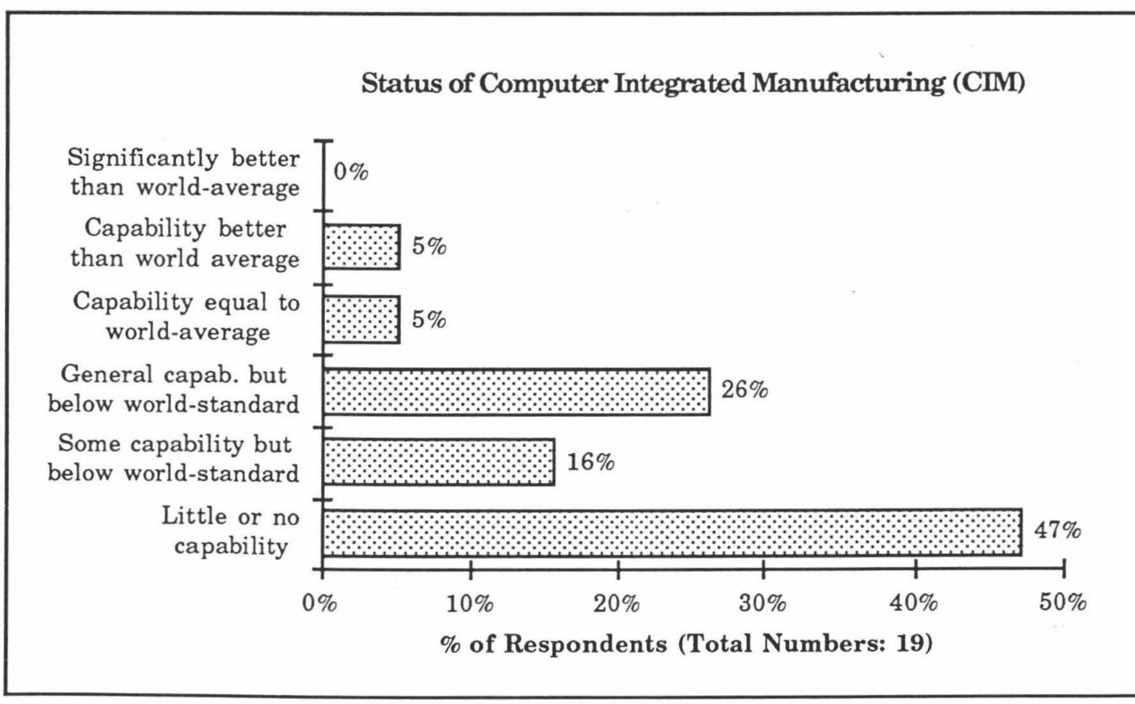


Figure 8.26 (b) Status of CIM

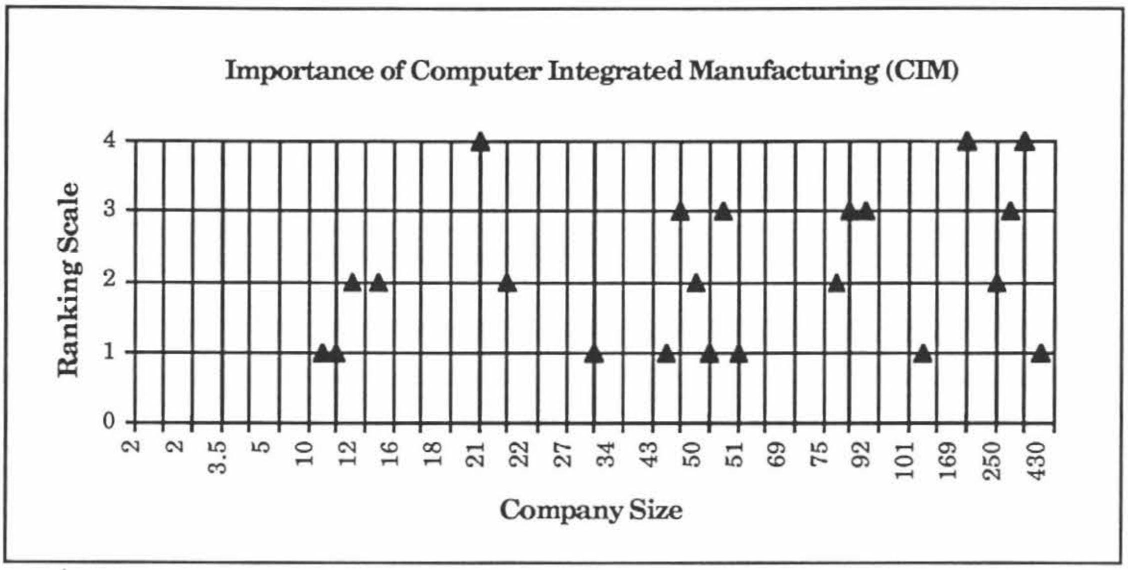


Figure 8.27 (a) Ranking Score Distribution of Importance (CIM)

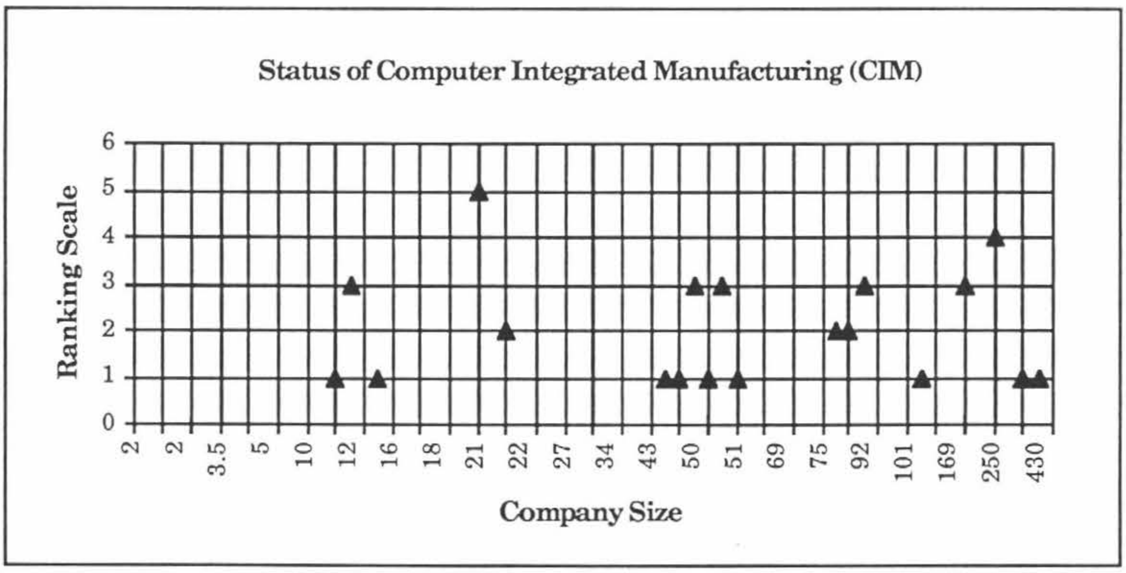


Figure 8.27 (b) Ranking Score Distribution of Importance (CIM)

Comments:

Most of the companies, including some large companies, had a very low status level for CIM. This trend is different from the current technology changes which was discussed in Section 8.3.

Chapter 9
Assessment of the Competitive Characteristics

9.0 Introduction

This chapter reports the results on how New Zealand plastics companies assess their competitive characteristics and provides an examination of the attitudes and concerns in the New Zealand plastics industry.

Six competitive characteristics in New Zealand plastics companies were evaluated, namely:

- Important strategic directions
- Marketing practices
- Planning control and appraisal methods
- Achieving competitive edge (quality, delivery, price, marketing)
- Management and engineering systems
- Supplier management

The importance of the specific competitive characteristics were ranked according to a five-point scale as:

Scale:
1 – Definitely unimportant
2 – Not important
3 – Moderately important
4 – Very important
5 – Essential

Two methods are used to evaluate the survey results. One is based on general analysis and the other is based on specific analysis. For general analysis, the average scores are evaluated with all the data provided by the respondents, no matter what the company size or type was. For the specific analysis, the average scores were evaluated with the data based on different company sizes and types.

9.1 Important strategic directions

There are four major types of grand strategies used by companies . These four grand strategies are described by Schermerhorn[1] as:

- *Growth strategies* seek greater size and expansion of current operation.

- *Retrenchment strategies* involve decisions to reduce operations and cut back in order to gain efficiencies and improve performance.

- *Stability strategies* maintain the present course of action without commitment to any major operating changes.

- *Combination strategies* simultaneously employ more than one of the other strategies. They often reflect different strategic approaches among subsystems.

The survey questions were focused on *growth strategies* and *retrenchment strategies*. The results indicated that some companies were using *combination strategies*. Respondents were asked to say how important they felt certain strategic directions would be in the future by scoring the different strategies. The general analysis of the data (see Table 9.1 and Figure 9.1) summarizes what particular strategies were essential or very important, etc.

Important Strategic Directions:	Answer Rate (%)	Average Score	Std. Dev. Value
New products for existing markets	92.31%	4.10	0.82
Increasing market share in existing markets	93.85%	4.08	0.84
New markets with new products	87.69%	4.07	0.92
New markets for existing products	92.31%	3.97	0.84
Rationalizing product range	86.15%	2.77	0.93
Growth by acquisition	81.54%	2.62	0.90
Withdrawing from some markets	75.38%	2.27	0.84

Table 9.1 Ranking of Important Strategic Directions

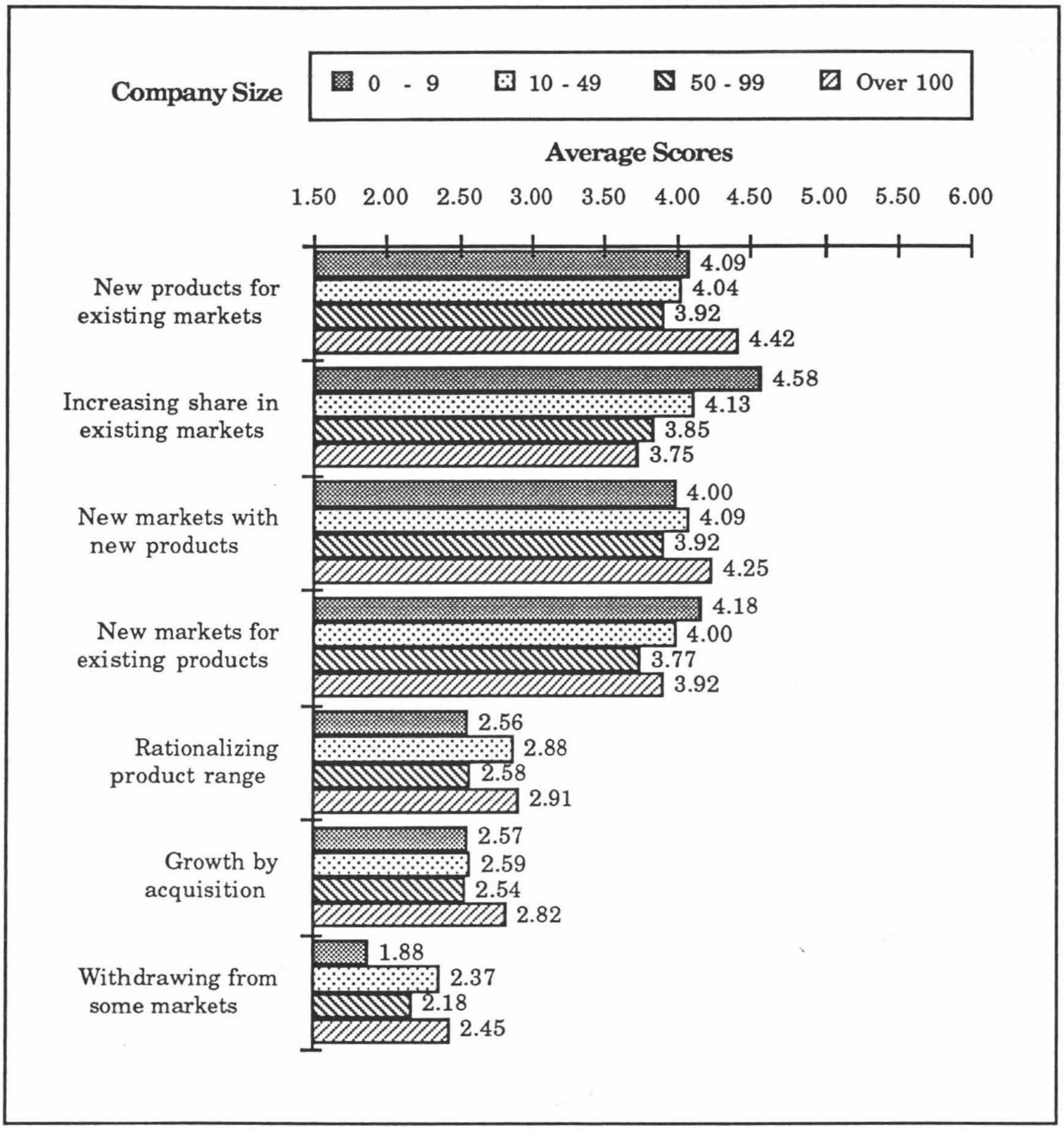


Figure 9.1 Ranking of Important Strategic Direction
(By Company Size)

The growth strategies can be pursued in different ways such as concentration and diversification. Concentration is internal growth by using existing strengths in new and productive ways, but without taking the risks of great shifts in direction. The growth strategies of this type include market development, product development, and innovation. Diversification is to pursue growth through the acquisition of new business in related or unrelated areas, or investment in new ventures. The common diversification strategies include horizontal integration, vertical integration, conglomerate diversification, and joint venturing.

According to the survey results, most companies appear to be basing their growth strategies for the future on concentration growth ranking "increasing new products for existing markets" with the highest average score of 4.1. "Increasing market share in existing markets", "new markets with new products and new markets for existing products" are also major factors in anticipated growth. However, the score of "growth by acquisition" was ranked significantly lower than other strategies, which means that most company don't want to change the basic nature of the organization. The survey also indicates that retrenchment strategies are less popular than growth strategies. The relatively low answer rate (75%) and low ranking scores (2.27) on "withdrawing from some markets" shows that most companies seek growth rather than retrenching in the future.

For the specific analysis, it is found that small size companies were more concerned about "increasing market share in existing markets", and large companies ranked "new products for existing markets" and "new markets with new products " as the first and second respectively. Because nearly all the small companies are distributors, their focus of strategic direction is market share. All the large companies are manufacturers, and their major strategic direction is new products or innovation. For the medium size companies, there are not clear difference between the growth strategies. It is also found that the strategic direction between the growth and retrenchment was significant. All the companies ranked "withdrawing from some market" as the lowest score. Retrenchment strategies seems to be an admission of failure and is viewed as a strategy of "last resort". But in today's difficult economic times, retrenchment strategies occur frequently and with new legitimacy. Whether New Zealand plastics companies should consider retrenchment strategies is worth further study.

9.2 Marketing management

Marketing has become a key factor for business success[2]. Today's companies face increasingly stiff and sophisticated competition, and the rewards will go to those who can best read customer wants and deliver the greatest value to their consumers. Marketing management is defined by Kotler[2] as :

> *Marketing management is the analysis, planning, implementation, and control of programs designed to create, build, and maintain beneficial exchanges with target buyers for the purpose of achieving organizational objectives.*

The survey listed several factors related to the marketing management. From the ranking scores (see Table 9.2), it can be seen that "sales forecasting" and "three-to-five year objective" were ranked first and second. "External advertising expenditure", "external marketing agencies", and "marketing consultants" were not ranked as important factors.

Marketing Management:	Answer Rate (%)	Average Score	Std. Dev. Value
Sales forecasting	90.77%	4.22	0.91
Three-to-five year objectives	96.92%	4.10	0.80
Written marketing plans	95.38%	3.73	1.03
Own market research programme	98.46%	3.58	1.05
Marketing representation on Board of Directors	73.85%	3.35	1.26
Separate marketing department	78.46%	2.90	1.20
External advertising expenditure	89.23%	2.71	0.99
Use of external marketing agencies	83.08%	2.63	1.20
Use of marketing consultants	76.92%	2.04	0.86

Table 9.2 Ranking of Marketing Management

The specific analysis of the survey results is also presented in Figure 9.2.

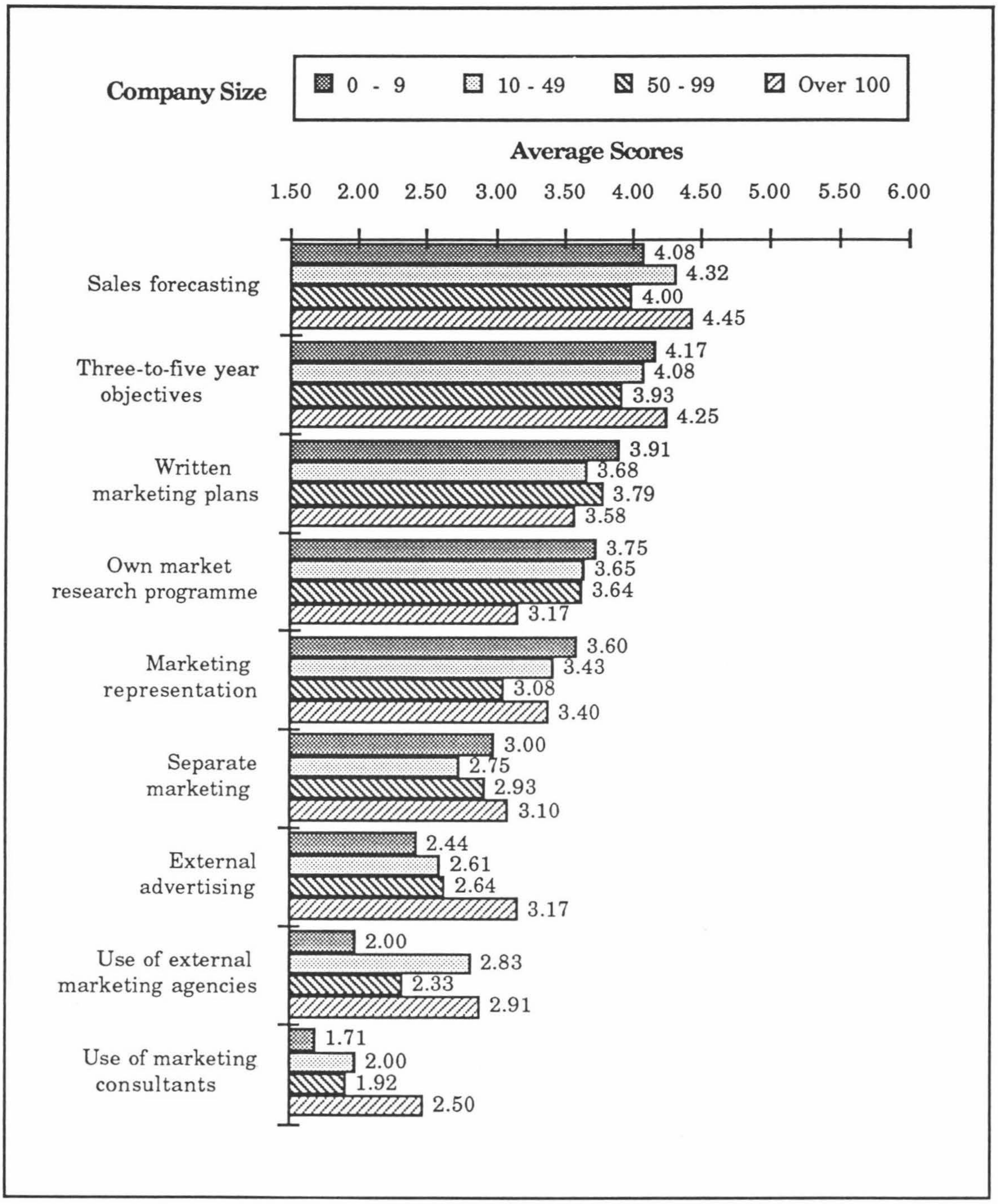


Figure 9.2 Ranking of Marketing Management
(By Company Size)

It was found that there is a significant difference between small companies and large companies in the ranking scores for the factors such as advertising, market agencies and market consultants. Large companies were more concerned about these factors than small companies because large companies can't afford to make mistakes for their marketing management and can provide high payments for external advice.

9.3 Planning, control and appraisal methods

There are four basic management functions, namely, planning, organizing, leading, and controlling. Planning determines what is to be achieved, setting goals, and identifying appropriate action steps. Organizing allocates and arranges human and material resources in appropriate combinations to implement plans. Leading guides the work efforts of other people in directions appropriate to action plans. Controlling monitors performance, compares results to goals, and takes corrective action.

In the survey, the respondents were asked to give their evaluation of the several methods relevant to the following two functions:

- Planning – such as budgeting, formal strategic planning etc.

- Control and appraisal methods – such as quality auditing, standard costing, payback period etc.

The survey results are presented in Table 9.3 and Figure 9.3.

Planning, Control and Appraisal Methods:	Answer Rate (%)	Average Score	Std. Dev. Value
Budgeting	93.85%	4.52	0.62
Quality auditing	92.31%	4.38	0.72
Standard costing	90.77%	4.03	0.81
Formal strategic planning	87.69%	4.00	0.89
Job/contract costing	81.54%	3.89	0.85
Process costing	78.46%	3.86	1.00
Internal rate of return	80.00%	3.81	0.89
Payback period	84.62%	3.76	0.79
Value engineering	56.92%	3.38	1.09
Discounted cash flow	69.23%	2.96	1.04
Batch costing	69.23%	2.96	1.04

Table 9.3 Ranking of Planning Control and Appraisal Methods

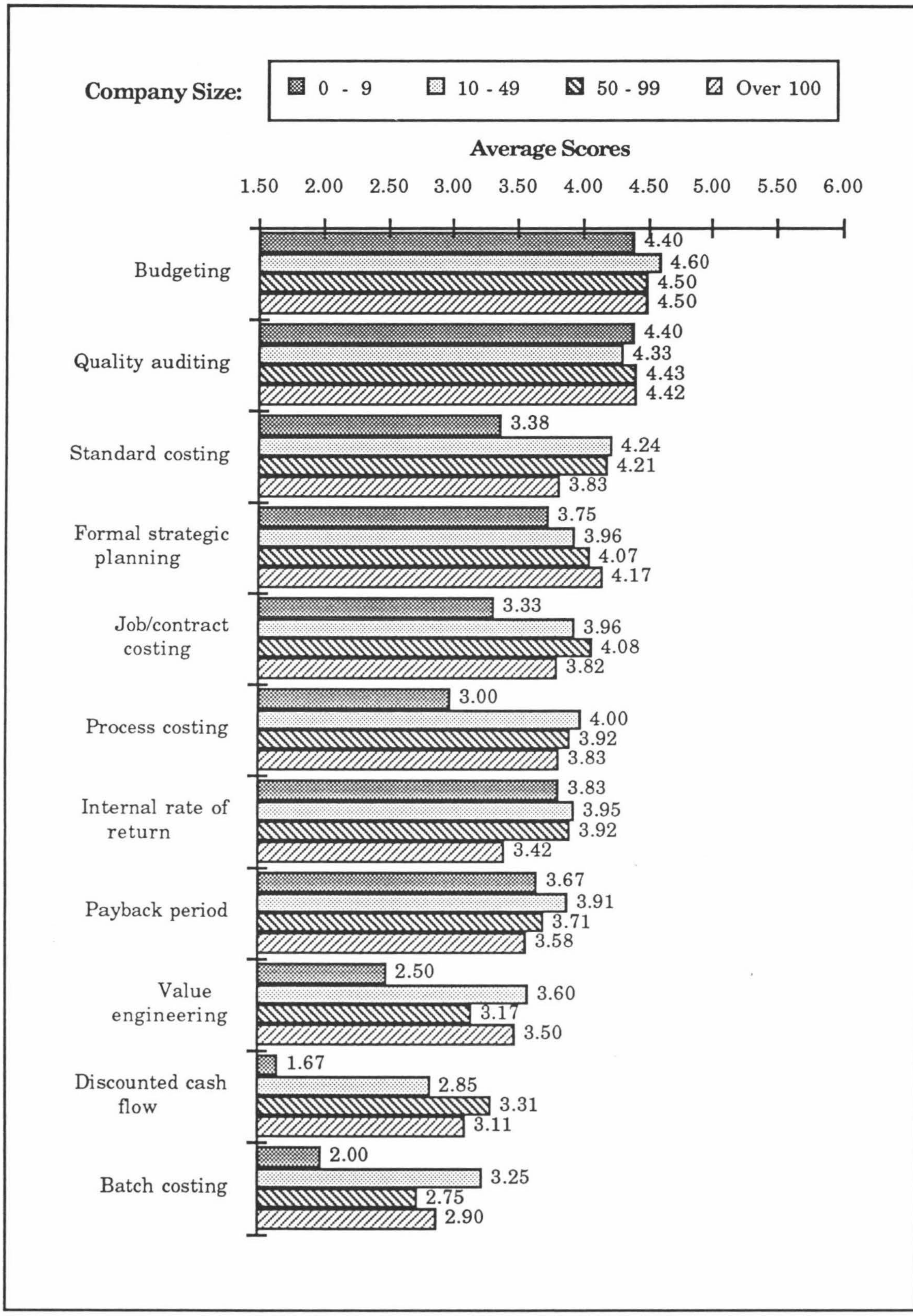


Figure 9.3 Ranking of Planning Control and Appraisal Method
(By Company Size)

As shown in Table 9.3, the relatively high answer rate (93.85%) and ranking score (4.52) on "budgeting" indicates that almost all the companies surveyed use some form of budgeting on a regular basis. Budgeting is one of the powerful management tools. It can help clarify and reinforce action priorities, maintain coordination, and facilitate evaluation and control of results.

For the specific analysis (see Figure 9.3), it was found that there is no significant difference to the scores ranked by different size companies on "budgeting" and "quality auditing" which further indicates that these two methods are widely used by the companies. Both "discounted cash flow" and "batch costing" were ranked a very low by the small companies. The reason for this is that most of small companies are distributors and these methods are not important for them.

9.4 Achieving competitive edge

The sources of competitiveness advantage are grouped into the following classes by Alberto[3]:

- Total cost
- Product quality
- Timeliness of delivery
- Time to introduce new products
- Dependability (in product quality, delivery time, etc.)
- Flexibility (product mix and capability)

This definition of competitive advantage derives from the fact that, in general, consumers choose among several product alternatives, which include the connected services, on the basis of the price-quality relationship. It is important to underline how, for manufacturing companies, market success is becoming more and more dependent on the ability to offer a balanced mix of products and services.

The factors deemed to be of critical importance for New Zealand plastics industry to achieve a competitive edge are listed in Table 9.4. To survive in the future, many manufacturers will be required to increase the proportion of their product in both domestic and global market[4]. Given this situation, it is encouraging to note the highly ranked scores to the quality factors such as consistent product quality (4.89), delivery reliability (4.71), giving value for money (4.5), and after-sale service (4.4). It also indicates an emphasis on trying to make a good balance between product and service by most of the companies.

Achieving Competitive Edge:	Answer Rate (%)	Average Score	Std. Dev. Value
Consistent product quality	95.38%	4.89	0.32
Delivery reliability	95.38%	4.71	0.46
Giving value for money	95.38%	4.50	0.62
After-sales service	92.31%	4.40	0.76
Product performance guarantee	93.85%	4.34	0.66
Delivery speed	95.38%	4.27	0.79
Manufacturing process flexibility	81.54%	4.23	0.78
Quality of sales representation	93.85%	4.21	0.82
Identifying market niche	93.85%	4.18	0.62
Stock availability	92.31%	4.12	0.90
New product technology	90.77%	4.07	0.72
Order system	93.85%	4.00	0.88
Product range	95.38%	3.97	0.75
Rate of new product introductions	90.77%	3.64	0.87
Credit terms	92.31%	3.33	0.95
On-line customer links	78.46%	3.29	0.99

Table 9.4 Ranking of Achieving Competitive Edge

The results shown in Figure 9.4 were further analysed according to company size. It was found that all the companies ranked product quality, total cost (giving value for money), and delivery with a relatively high scores. This coincides with the views of Alberto[3]. Compared with the survey results of New Zealand manufacturing capabilities needed to achieve competitiveness (see Figure 3.2 in Chapter 3), it was also found that New Zealand plastics companies had a similar ranking order for the importance of competitive abilities.

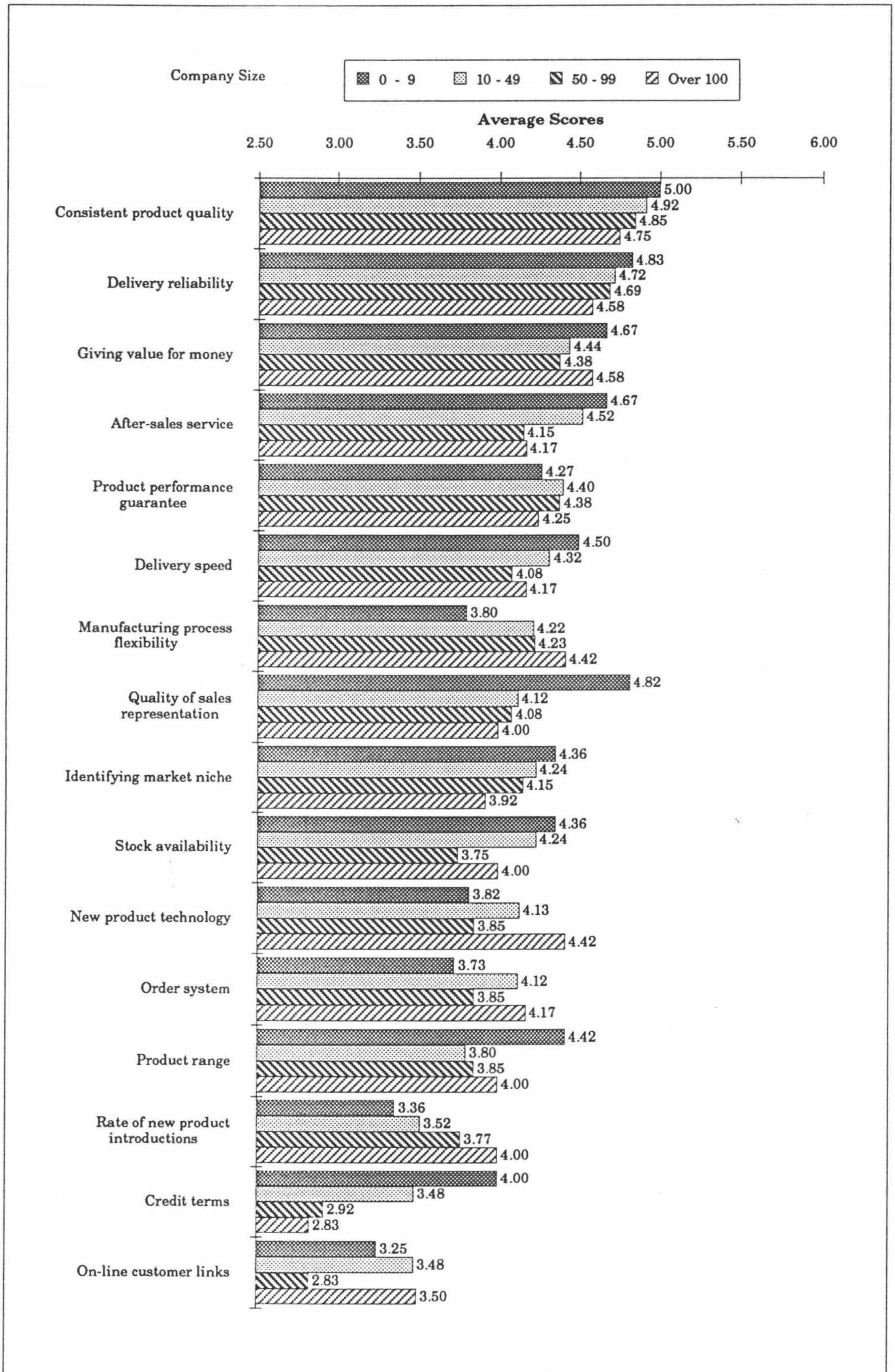


Figure 9.4 Ranking of Achieving Competitive Edge
(By Company Size)

9.5 Management and engineering systems

Quality must be a key goal in the operations function and in all other parts of a company. It is important that customers perceive quality in their contacts with all aspects of the company from the first sales brochure or sales call through the billing cycle and throughout the life cycle of the goods or services purchased. If a company is to be competitive, quality work is also important in all support activities that customers do not see, such as scheduling and materials management.

Management and Engineering Systems:	Answer Rate (%)	Average Score	Std. Dev. Value
Total quality management	86.15%	4.34	0.69
ISO 9000 series	84.62%	4.31	0.77
Kaizen - Continuous improvement	73.85%	3.94	0.95
Reliability engineering	66.15%	3.84	0.92
Zero defects	69.23%	3.82	1.05
Expert systems in manufacturing	66.15%	3.63	0.98
Rapid prototyping	60.00%	3.54	0.91
Material resource planning(MRP) system	66.15%	3.47	0.93
Statistical process control	70.77%	3.43	0.75
Just in time (JIT) manufacturing	67.69%	3.27	1.17
Quality circles	66.15%	3.07	1.08
Concurrent engineering	47.69%	2.94	1.09
Kaisha - Dominant market share strategies	61.54%	2.85	0.98
Theory of constraints assembly line design	47.69%	2.81	1.05
Kanban - visible card system	49.23%	2.81	0.97

Table 9.5 Ranking of Management and Engineering Systems

The survey responses given in Table 9.5 reinforce the emphasis on quality noted earlier. “TQM” was seen as the most important factor with a ranking score of 4.34, followed by “ISO 9000 series” with the second highest ranking score of 4.31.

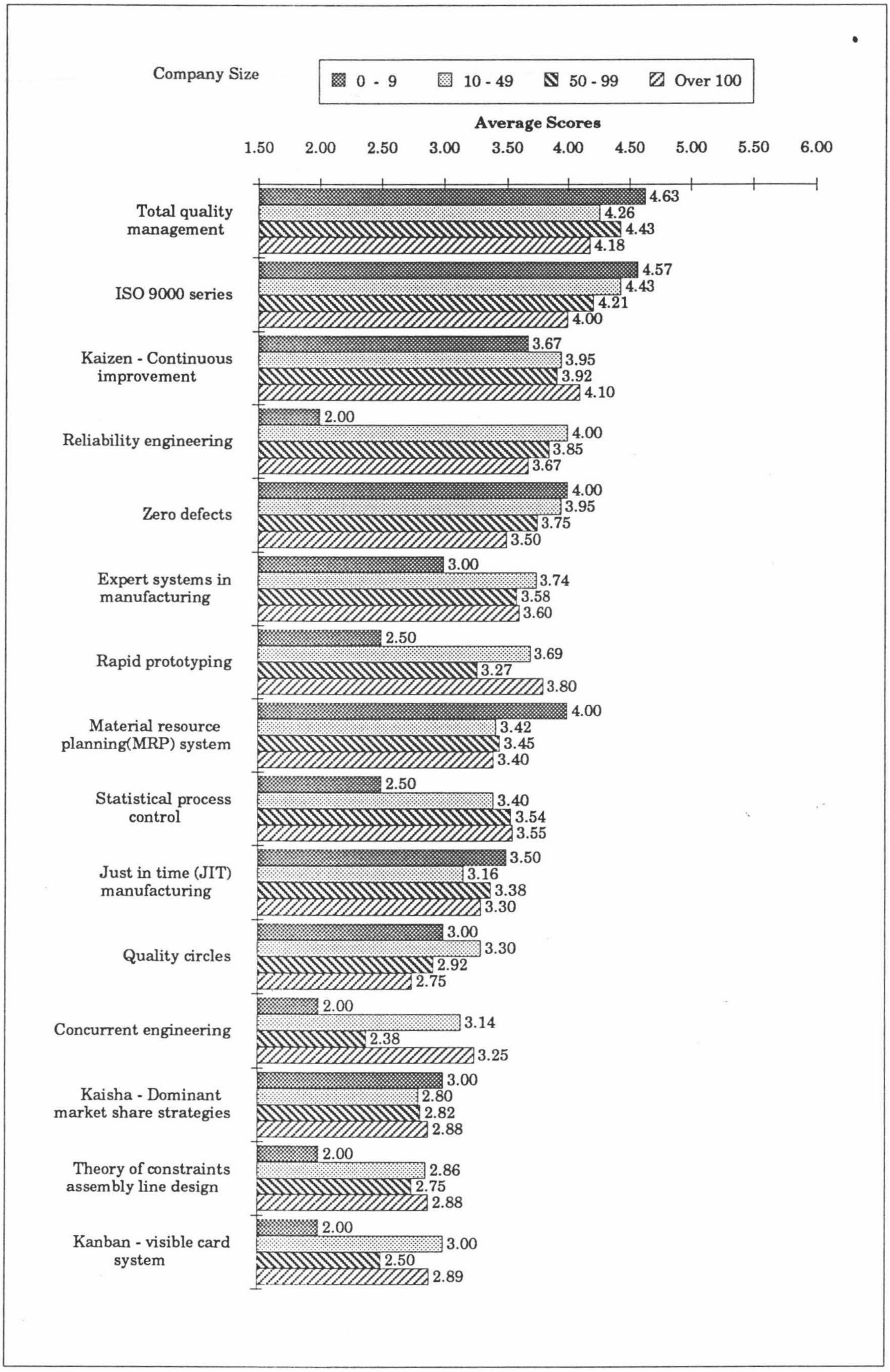


Figure 9.5 Ranking of Management and Engineering Systems
(By Company Size)

It is worth noticing that the engineering factors were not ranked highly, especially by most of the small companies (see Figure 9.5). For example, “reliability engineering”, “rapid prototyping”, “concurrent engineering” and “theory of constraints assembly line design” etc., were ranked with a relatively lower score because they were not seen as applicable for them.

9.6 Supplier management

Finally, the survey results (see Table 9.6) indicates that the majority of companies treated “the ability to maintain quality and delivery”, “high ethical standards and relationship”, and “obtaining competitive prices” as most important for supplier management to achieve competitive capabilities, with the ranking scores of 4.76, 4.62 and 4.4 respectively. The response rate to above three factors was over 96%.

Supplier Management:	% of Answers	Average Score	Std. Dev. Value
Ability to maintain quality and delivery	96.92%	4.76	0.47
High ethical standards and relationship	96.92%	4.62	0.55
Obtaining competitive prices	96.92%	4.40	0.64
Purchasing control system	90.77%	3.92	0.82
Co-ordination with other functions	92.31%	3.88	0.83
Advice on make-or-buy decisions	84.62%	3.58	0.94
Knowledge of government regulations	93.85%	3.34	0.96

Table 9.6 Ranking of Supplier Management

Further analysis based on different size companies is shown in Figure 9.6.

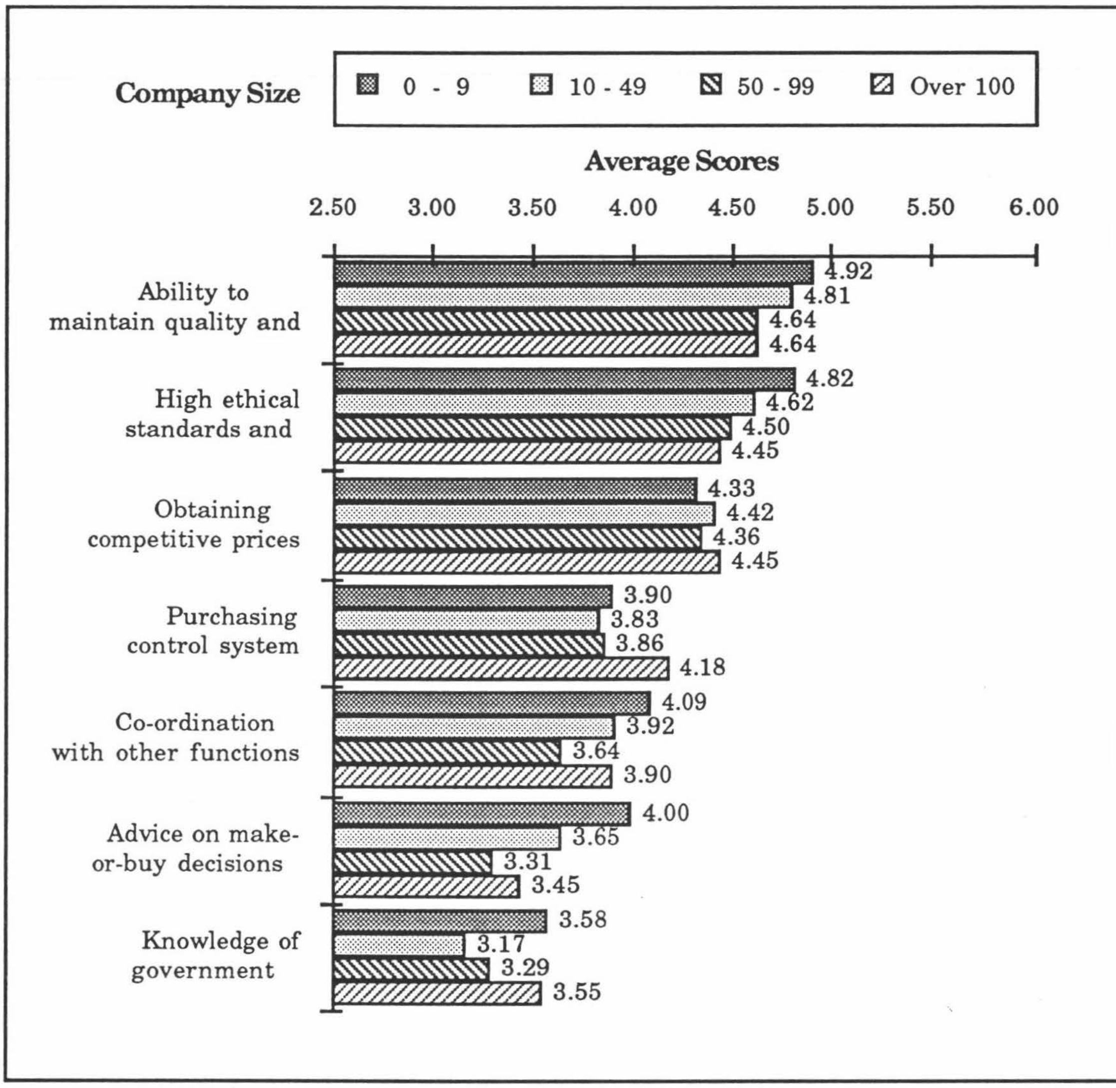


Figure 9.6 Ranking of Supplier Management
(By Company Size)

9.7 Recommendation

When putting all the ranked data together (from Table 9.1 to Table 9.6) , the following ten highly rated issues about the competitive characteristics became apparent:

- Consistent product quality
- Delivery reliability

- High ethical standards and relationship (supplier management)
- Budgeting
- Giving value for money
- After-sale service
- Obtaining competitive prices
- Quality auditing
- Product performance guarantee
- Total quality management

Figure 9.1 shows the overall picture of the ten highest rated issues.

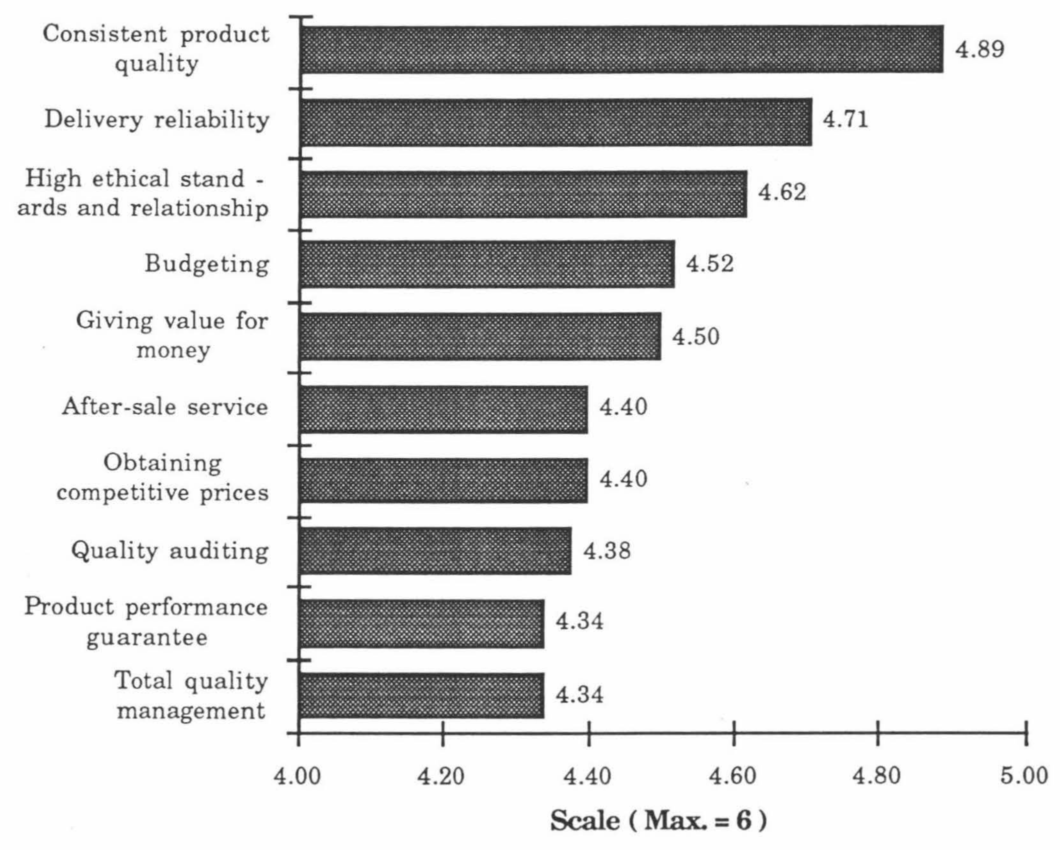


Figure 9.7 Ten Highest Rated Issues

Note:

In the ranked data shown in Figure 9.7, "ability to maintain quality and delivery" (supplier management) was rated with a score of 4.76, but it is similar with "consistent product quality" and " delivery reliability". So it wasn't included in the ten highest rated issues.

- Comparing with overseas companies

Comparing the survey results (see Figure 9.7) with the survey of overseas companies about the key issues of competitiveness (see Table 3.1), it can be found that there are considerable similarities in concerns about the quality issues. The companies in Europe, North America and Japan all ranked the “manufacturing to quality standard” with the highest score.

However, there are also differences in other issues. The overseas companies regarded “new product introduction” as one of the important key issues: for example, Japanese companies ranked it as the second and American companies ranked it as the third. It would appear that New Zealand plastics companies haven't given this issue enough emphasis. Although “new product introduction” was ranked the highest in *Important Strategic Direction*, this issue wasn't listed in the ten highly rated issues (see Figure 9.7). This seems to be related to a relatively low percentage of R&D investment (see Figure 6.7 in Chapter 6).

- Comparing with other New Zealand manufacturing companies

Comparing the survey results shown in Figure 9.7 with the survey of other New Zealand manufacturing companies (see Figure 3.2), it is also found that New Zealand plastics companies have the same attitude as other manufacturing companies on some issues such as “conformance” and “delivery”, but plastics companies were more concerned about the issue of “high ethical standards and relationship”.

Chapter 10
Conclusion and Recommendation

The following major issues are summarised from the previous discussions in this thesis.

(1) The importance of technology and innovation

Over the last 100 years, the structure of world trade has fundamentally changed, for example, the world trade in agricultural products decreased from 76% in 1888 to only 9% in 1988. However, New Zealand has not changed enough to keep the world pace, agricultural products and food items are still a major part of export (totally 66%). It should be noted that success in international trade has become more a function of the ability to develop and deploy technology and skills than of proximity to low-cost inputs. Innovation, in the broadest sense of the term, has become vital to the success in global competition. Restoring prosperity demands that New Zealand industry upgrade and broaden its competitive advantage by giving more emphasis on the technology and innovation issues.

(2) New Zealand manufacturing future

Based on the comparison of the survey of manufacturing strategy between the overseas and New Zealand's companies, the following issues are summarized:

- Improving competitiveness depends on linking manufacturing strategy to business strategy, and quality function is one of the critical factors in manufacturing strategy.

- New Zealand's manufacturing industry had the same attitudes and concerns as the other industrial countries about "product conformance".

- New product introduction has become an important factor in competitive ability, but New Zealand manufacturing companies didn't ranked it as critical factor. More efforts to improve innovation activities are required.

- For New Zealand manufacturing industry, "delivery reliability" was given more concern than other industrial countries.

- People skills training was regarded as one of the urgent needs for New Zealand manufacturing industry to improve its productivity and competitiveness.

(3) The situation of plastics industry in the global economy

The plastics industry plays an important role in the manufacturing industry because of its relationship with other industries. The resin sales and demands for plastics machinery indicated that the world-wide recession continues to plague most of the major plastics producing countries such as European countries, Japan and United States. How to increase competitiveness with technology innovation and how to retain constant high-quality criteria are becoming more important issues for the plastics industry.

(4) Profile of the New Zealand plastics industry

Some information relevant to the New Zealand plastics industry are summarized as:

- The company type and personnel percentage are related to the company size (staff number). In a small size company (staff number under 9) there is a very high percentage of importers & distributors, and a high percentage of executive, administration and sales. Nearly all the medium and large size company (staff number over 50) are manufacturers, and have a high percentage of skilled and unskilled people.

- Survey results showed that nearly 44% of New Zealand plastics manufacturing companies haven't had important links with overseas companies. Further analysis is suggested to find out why so many companies haven't recognized the importance of technical linkage with overseas companies.

- The ratio of R&D to capital investment in New Zealand plastics companies in 1993 is very low when compared with Japanese companies in 1987. Whether New Zealand plastics companies need to follow Japanese pattern in technology investment should be studied further.

- Resin is a major product in the marketplace, however, nearly 80% of the resins sold in New Zealand were imported from overseas. In terms of manufacturing, the major activity of the New Zealand plastics industry is plastic material processing and plastic product manufacturing, especially the production of packaging products.

- Although more than 80% of plastic products were sold in the domestic market in 1993, the ratio of export to import has increased since 1990.

(5) The key issues of the New Zealand plastics industry

The following key issues are summarized from the comments given by the survey respondents:

- Lack of people skills is a widespread problem faced by New Zealand manufacturing industry. The survey of the New Zealand plastics industry also indicated the same problem. Therefore, improving training and education system is an urgent need.

- The critical technology changes for New Zealand plastics industry are likely occur in a series of areas, such as recycling and resin process technology, robotics and automation, tool and mould design, film co-extrusion, and process control.

- Tool and die making has become an important part of the New Zealand plastics industry.

(6) Technology status of the New Zealand plastics industry

- The following techniques and processes are considered to be the important candidates for technology upgrading to improve competitive advantage based on the gap between the importance and status and the weighted measures shown in Figure 8.3 and Table 8.4, namely:

  i) Hydraulic moulding presses
  ii) Blow moulders
  iii) Robots and automation
  iv) Flexible manufacturing systems (FMS)
  v) Computer aided manufacturing (CAM)
  vi) Injection moulds
  vii) Extruders
  viii) Mixers
  ix) Computer integrated manufacturing (CIM)

- Although both injection and extrusion techniques were ranked first and second in status, the weighted measures of importance and gap between importance and status was still found a relatively high compared with other techniques. This suggests that keeping up with world leading technology in these technical areas is necessary and further technology transfer is needed.

- Both importance and status of Computer Integrated Manufacturing (CIM) were ranked the lowest and this is of concern. A recent study by Mazany[3] indicated that implementing a CIM strategy is vital for New Zealand's economic fortunes, since it provides one key component by which many organizations can improve their operations to become internationally competitive. *Further investigation need to be carried out to see why the New Zealand plastics companies ranked CIM so low.*

(7) Competitive capabilities of the New Zealand plastics industry

- Ten highly rated issues are recommended for the New Zealand plastics companies to achieve the competitiveness, namely:

  i) Consistent product quality
  ii) Delivery reliability
  iii) High ethical standards and relationship
  vi) Budgeting
  v) Giving value for money
  vi) After-sale service
  vii) Obtaining competitive prices
  viii) Quality auditing
  ix) Product performance guarantee
  x) Total quality management

- It was found that there are considerable similarities in quality issues between New Zealand plastics companies and overseas companies (Europe, America and Japan). However, there are also differences in other issues. The overseas companies regarded "new product introduction" as one of the important key issues, for example, Japanese companies ranked it as the second and American companies ranked it as the third. It would appear that New Zealand plastics companies haven't given this issue enough emphasis. Although "new product introduction" was ranked the highest in *Important Strategic Direction*, this issue wasn't listed in ten highly rated issues (see Figure 9.7). This seems to be related to a relatively low percentage of R&D investment (see Figure 6.7 in Chapter 6).

- It was also found that New Zealand plastics companies have the same attitude as other New Zealand manufacturing companies on some issues such as "conformance" and "delivery", but plastics companies are more concerned about the issue of "high ethical standards and relationship".

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Appendix I
Survey Questionnaire

The survey questionnaire contains three parts, namely:

Part A – General Enquiries
Part B – Techniques and Processes
Part C – Competitive Capabilities

PART A -- General Enquiries

Name of Respondent:	
Title of Position:	**Phone:**
Company:	

1. Personnel:

	Number and/or	Percentage %
Executive		
Sales		
Technical		
Administration		
Skilled		
Unskilled		
Total		

2. Technical Linkages:

	Yes	No
Is your company a subsidiary of an overseas company?		
If so, is that parent company an important source of technology?		
Do you have important links with other overseas companies?		

3. Investment in Technology:

Approximate percentage of turnover:

	$ Spent or	Percentage %
External training		
In-house training		
R&D		
Technological equipment		
Capital equipment		
Building(hire or purchase)		
Salaries(technical)		

4. Key issues

1). Do you have any problems in the following areas?

	Yes	No
Keeping up with technology		
People skills		
Shortage of resources:		
Capital		
Personnel(numbers)		
Buildings		
Equipment		
Technology		
Other: (please specify)		

For the areas in which you have problems, what are you doing to solve the problems?

(Attach a sheet if space above is insufficient.)

2). Which of the following product groups does your company supply?

Please tick appropriate box: ✓

	Distribution or Importer	Manufacturer
Resins		
Pipes,piping,tubing and hose		
Guttering and fittings		
Plumbing ware		
Profile shapes		
Thermoformable rigid sheets, including foils		
High pressure laminates		
Flexible sheetings, supported or unsupported		
Foamed materials		
Films produced by extrusion process		
Bags, sachets and other flexible containers		
Tapes, self-adhesive and others		
Floor coverings		
Bottles, jars and similar rigid containers		
Industrial containers over 10 litres in capacity		
Kitchen and tableware and household utensils		
Cabinet makers and builders hardware		
Other plastic articles		
Other : (please specify)		
Other : (please specify)		

3). Product market

	Value \$ and/or	Percentage %
Domestic		
Export		

4). Where do you think the critical technology changes are likely to be implemented for the New Zealand plastics industry?

Please give your comments:

(Attach a sheet if space above is insufficient.)

5). We have been advised that improving tool and die making is a critical need in the plastics industry.

Do you think the tool and die making has become an important part of New Zealand plastics industry?

---- Yes ---- No

Please give your comments:

PART B -- Techniques and Processes

Two pieces of information are required:

1) The assessment of the importance of the particular technology to the product you produce.
2) The assessment of your company's technological status relative to the world status

The scale to be used for importance is as follows:

na Not applicable
1 Of marginal importance
2 Important but not essential
3 Important and essential in many applications
4 Essential in all applications

The scale to be used for status is as follows:

na Not applicable
1 Little or no capability
2 Some capability but not sophisticated
3 General capability but below world standard
4 Capability equal to average in the world
5 Capability better than world average but not particularly outstanding
6 Significantly better than the world average for this particular technique

Please tick appropriate box : ✓

	Importance					Your Company Status						
Specific Techniques and Processes:	na	1	2	3	4	na	1	2	3	4	5	6
Blow moulders												
Calenders												
Compounders												
Compression moulders												
Extruders												
Foaming machines												
Grinders												
Hydraulic moulding presses												
Injection moulders												
Laminators												
Mixers												
Rolling mills												
Thermoformers												
Vacuum formers												
Other : (please specify)												
General Techniques and Processes:	na	1	2	3	4	na	1	2	3	4	5	6
Robots and automation												
Computer aided design(CAD)												
Flexible manufacturing												
Computer aided manufacturing(CAM)												
Computer integrated manufacturing(CIM)												
Other: (please specify)												

PART C -- Competitive Capabilities

Objective:

There is increasing evidence from a number of studies that proper strategic direction can significantly improve the competitive strength and business performance of an organization.

The following questionnaire aims to gather information on how New Zealand plastics companies assess their competitive abilities relative to the market requirements they face, how well they have improved their recent performance, the importance they attach to objectives related to the competitive dimensions, their current practices and concerns, and their plans to improve their operational effectiveness

Requirement:

We need your assessment on the importance of the specific competitive capability.

The scale to be used for importance is as follows:

na ---- Not applicable	3 ---- Moderately important
1 ---- Definitely unimportant	4 ---- Very important
2 ---- Not important	5 ---- Essential

1. Important Strategic Directions:

Please tick appropriate box : ✓

	na	1	2	3	4	5
Increasing market share in existing markets						
New products for existing markets						
New markets for existing products						
New markets with new products						
Growth by acquisition						
Rationalizing product range						
Withdrawing from some markets						
Other : (please specify)						

2. Marketing Practices:

Please tick appropriate box : ✓

	na	1	2	3	4	5
Sales forecasting						
Three-to-five year objectives						
Written marketing plans						
Own market research programme						
Separate marketing department						
Marketing representation on Board of Directors						
Use of external marketing agencies						
External advertising expenditure						
Use of marketing consultants						
Other : (please specify)						

na ---- Not applicable	3 ---- Moderately important
1 ---- Definitely unimportant	4 ---- Very important
2 ---- Not important	5 ---- Essential

3. Planning Control and Appraisal Methods:

Please tick appropriate box : ✓

	na	1	2	3	4	5
Budgeting						
Quality auditing						
Standard costing						
Payback period						
Formal strategic planning						
Internal rate of return						
Job/contract costing						
Process costing						
Discounted cash flow						
Batch costing						
Value engineering						
Other : (please specify)						
Other : (please specify)						

4. Achieving Competitive Edge:
(Quality, delivery, price, marketing)

Please tick appropriate box : ✓

	na	1	2	3	4	5
Consistent product quality						
Product performance guarantee						
Delivery reliability						
Delivery speed						
Order system						
Stock availability						
Manufacturing process flexibility						
Giving value for money						
Quality of sales representation						
Product range						
Identifying market niche						
After-sales service						
Rate of new product introductions						
New product technology						
On-line customer links						
Credit terms						
Other : (please specify)						
Other : (please specify)						
Other : (please specify)						

na ---- Not applicable	3 ---- Moderately important
1 ---- Definitely unimportant	4 ---- Very important
2 ---- Not important	5 ---- Essential

5. Management and Engineering Systems:

Please tick appropriate box : ✓

	na	1	2	3	4	5
Expert systems in manufacturing						
ISO 9000 series						
Total quality management						
Reliability engineering						
Statistical process control						
Kaizen - Continuous improvement						
Quality circles						
Zero defects						
Kaisha - Dominant market share strategies						
Just in time (JIT) manufacturing						
Material resource planning(MRP) system						
Theory of constraints assembly line design						
Rapid prototyping						
Concurrent engineering						
Kanban - visible card system						
Other : (please specify)						
Other : (please specify)						
Other : (please specify)						

6. Supplier Management:

Please tick appropriate box : ✓

	na	1	2	3	4	5
Ability to maintain quality and delivery						
Obtaining competitive prices						
Purchasing control system						
High ethical standards and relationship						
Co-ordination with other functions						
Advice on make-or-buy decisions						
Knowledge of government regulations						
Other : (please specify)						
Other : (please specify)						
Other : (please specify)						

Appendix II
Comments on the Critical Technology Changes

The survey respondents were required to give their comments on the question " where do you think the critical technology changes are likely to be implemented for the New Zealand plastics industry?".

The comments were presented as:

- Process control, automation and quality system.

- Non use of heavy metals, quick change tooling.

- Gradually upgrading their technology in line with overseas practices although New Zealand's film extrusion technology is up with the best worldwide.

- Machinery, resin alloys, processes.

- Production costs getting less with better machines, thinner films, stronger, more higher performance films. Faster extruders i.e. meters per-minute equal to less equipment, more output with price margins getting finer and finer. Companies will need better equipment to compete.

- In injection moulding - the adoption of CAD/CAM as a norm for design and tool making.

- Robotics;
  Composite structures requiring change in processing;
  Recycle problems.

- Effective use of recycled material. Fast efficient mould changes for relatively short production runs. Good mould design to allow lighter weight bottles with good drop strength.

- Development of new barrier films.
  Development of new products aimed at primary industry packing needs.

- Recycling will become important in polymer selection.

- Resin technology will continue to improve allowing plastics to penetrate more markets not currently accessible to plastics.

- New resins and composite resins will require new processing/technical skills. High cost of technology, barrier to new resins, to compete with imports.

- New resins enabling better performance in all areas;
  Increasing the recycling capability of plastics;
  Increasing use of co-extrusions;
  Improved process control;
  (In our extrusion and die concepts).

- The area of recycling has to be tackled as the western world seems to be miles ahead. New Zealand must set up viable industry to use re-cycled polymer. The public are demanding it be done.

- Injection moulding machines, moulds, robots, automation.

- Co-extruded film in order to better recycle plastic.
  Packaging will change to minimise both materials and energy.

- Modification/or blending of existing polymers
  Recycle/environmental issues
  Advances in machine technology

- Within our industry it will be through changes in materials used and equipment.

- Technology in recycling of plastic materials and sale of these materials.

- The industry must spend more on Research & Development and more school leavers should be encouraged into the A.T.I./Polytechnic courses etc. Raw material changes to "Environment Friendly" products. More widespread usage of re-cycled plastic granules in new products.

- Recycling - public image and knowledge of the efficient use of plastics.

- Automation, die design, new materials
  Material consistency - being able to analyse materials before use for suitability

- Gravimetric control of resin usage
  Bulk handling
  Computer controlled extrusion / injection / blow moulding
  Re-processing

- In the areas that would make the ever-present
  Short-productions runs cost efficient, and better production handling methods

- Automation - robotics.
  More towards volume for export rather than domestic short run.

- The introduction of higher performance plastics, necessitating higher technology levels
  The adoption of a 'green' philosophy
  Lower cost production techniques

- Computer control
  Raw materials

- Tooling - improved quality and design
  System of tooling manufacture
  Also materials, new resins, improved resins etc.

- Environmental issues - plastics becoming recyclable and reusable in food grade products.

- Moving to specialised materials and value added packaging. More point of sale marketing i.e. better presentation.

- Generally the same as for anywhere in the world but with emphasis on servicing high quality technology industries with quality design, tool making and moulding services.

- N.Z. market is too small to compete overseas, the need to automization is very important, this of course won't help our unemployment problems at all.

- Recyclations for toxicity, especially related to food contact application for export products.

- We are the world leader in thin layer laminates - co-extrusion. This will allow us to develop multi-layer structures for food packing, industrial and packaging applications. e.g. stay-fresh film for food, greenhouse films, courier bags and building "papers".

- Being able to invest in latest processing equipment. There have been no radical changes in processing methods but control systems have undergone major changes.

  To meet international quality requirements we need sophisticated equipment.

- Tool and die manufacture - cost and time. New materials.

- No critical changes. N.Z. has always kept with up-to-date technology

- In our sector, being the rigid packaging sector, I see barrier materials or technology, coupled with the current recycling problems of multi-layer packing being the next major opportunity for critical technological change.

- Use of recycled plastics.
  Development of substitutes for cardboard and wood.
  The application of overseas technology to New Zealand markets.

- The improvement in resins with increased barrier capabilities and/or the improvement in processing equipment to produce complex co-extruded structures.

- Materials - changes involving the environment and their suitability.

  Materials and machinery for further development of primary products and their export i.e. controlled atmosphere.

- New materials and applications will impact the industry and its ability to obtain the technology and modify its manufacturing processes quickly to stay ahead will determine its success.

- Recycling, implications of resource management etc.

- Material performance

- Through design and speed of machinery.

- We see the emergence of New Zealand as a sophisticated short production run supplier to world markets using advanced engineering materials with some "home grown" products. Current examples as in Fisher & Paykel Medical Units and Tru Test Plastics Milk Meters.

  Plastics as packing in the export market with particular emphasis on high barrier property flexible films will grow with new technology and be complimentary to "value added" food exports.

- More plastics use in automotive applications, particularly composites.
  Recycling of plastics.

- Formulating relative to cost reductions
  Computerised production systems
  Material monitoring and control systems

- Availability of new plastic raw materials
  New/different processes to lower costs, particularly wastage rates.
  New techniques in recycling of waste.

- Flexibility - to suit short runs. Process control - to aid product quality. Improved Research & Development to utilise latest polymer innovations.

- Overseas development of energy efficient processing equipment in conjunction with New Zealand's relatively low energy costs will assist our competitiveness. Automated plant and robotics being used overseas will make it more difficult to compete in export markets.

- Better use of energy.
  The recycling of waste/used materials into other forms of products.
  Overcoming adverse public opinion on the use of plastics i.e. environmental concerns.

- Computerisation of packaging manufacturing and conversion processes e.g. printing, laminating bag/pouch manufacture. i.e. greater quality, reproducibility and efficiency.
  Competition from Asian importers.

Appendix III

Comments on the Importance of Tool and Die Making

The comments given by survey respondents who thought the tool and die making is a critical need in the New Zealand plastics industry are summarised as follows:

- As above, quick change tooling require to encourage low inventory.

  Quality of tooling is important, also along with the design innovations in product aid tool.

- Because of its small size demands versatility in moulds and capacity.

- The product is only going to be as good as dies, extrusion or mounding. With the downturn of the past few years in the plastics industry a lot of these skills were lost. Now that the industry is starting to pick up again, there is a shortage of these skills to call upon.

- The tool making industry lost many skilled toolmakers and shops from 1987 to 1992. The skills have not been replaced. Also the techniques of tool making are changing and I do not see nearly enough adoption of these (machinery) or training of new technicians.

- Tool and die making is an essential part of any plastics industry. It has always been an important part of the NZ plastics industry and will remain so.

- Without quality tooling you can not get quality products at economic cycle times.

- Injection moulded components are a key part of our business development.

- World technology is not currently applied in New Zealand - due to lack of scale (expensive equipment techniques).

- Unless you have good tools you shouldn't be in the plastics manufacturing business.

- We are not involved in injection, blow moulding etc., so do not have much to do with die making. However in extrusion, new die concepts particularly with respect to multi-layer film structures are emerging. These are being developed by the machine suppliers (offshore) and effectively form part of any machine being bought.

- In the past, local toolmakers had problems with quality. Moulds were sourced from overseas at great expense. Toolmakers within New Zealand can now compete in the areas of quality and price and New Zealand is now being recognised as a potential leader in this area.

- Tool and die making is a special skill - those that already have these skills in-house are very fortunate as the quality of the product is reliant on this critical area. Not only is the making of dies important but also the design and the systems employed to design work are equally important.
- In an effort to became cost competitive, die making and design is a key component - "hot runner" systems - less weight fittings - faster cycles all pertain to die design and making.

- Without a broad based and technology advanced tool making industry the plastics industry will falter.

- Onshore tool making facilities are essential to success of Plastics Industry. There is a shortage of skilled toolmakers in New Zealand.

- High quality tool and die making is a key to success. With the increasing requirement for ISO 9000 series acceptation, quality has become a major issue, and product quality revolves around tools and dies.

- Tool making is of a good standard at a reasonable price. There is a need for a higher level of tool design to obtain the optimum from high technology moulding machines.

- It is where it all starts. However too many people have an attitude which is cost based only about tool making. This is relevant to the product being made but people seem to expect silk purses out of sows ears.

- We are often asked to help our customers modify the polymer properties in order to enable effective extrusion or moulding. Sometimes it is the limitation of the die or tool that prevents the product being made.

- Many of our tool making companies fell over post 1987. Much of the NC machinery has left the country. There has been almost no training of tool making apprentices in the last few years.

- Obviously!!! Need for reduced cost and faster development times.

- Tool and die making has always been critical to the plastics industry. What is needed now is the competitive (internationally) turnaround of projects which should be achievable with CAD/CAM becoming more accessible.

- Timeliness of tool manufacture, cost, design input from toolmaker.

- Die making has always been a critical if neglected requirement of the Plastics Industry. The need for quicker deliveries to bring new products to market is essential, improved methods such as CAD/CAM have assisted but further advances are necessary.

- We do not have our own die makers however the tool makers we use do produce a quality product.

- In the extrusion process, we are well supported by the tool and die makers. However, we have been given the impression that diversifying into moulding may require us to source some of our tools and dies from other countries besides NZ.

- Local adaptability and response times important for export oriented business. A lot of local market material can be sourced (equipment) from Australia or Asia.

- Tooling has always played a part in the industry. Over the last few years there has been a greater need to work closer to achieve better and more commercial results.

- With the current uncertainties in Europe, particularly eastern Europe, we should be planning for the future and offering favourable emigration plans for skilled toolmakers.

- Always has been - but many tool and die makers retrenched or closed due to depressed manufacturing.

- Good toolmakers are in short supply. Skills and training have been neglected. Forces manufacturers to go offshore. Not enough attention is given to training apprentices as the economy improves so manufacturing will suffer.

- It is important. Previously well established in New Zealand but the industry recession in late 1980's and mould imports from overseas forced many good toolmakers overseas. Demand now re-established. Training (especially Hutt Valley Polytechnic, Manukau Polytechnic etc.) should be able to support.

- Tool and die manufacture must keep up with developments in the new technology moulding machinery.

- Essential to maintain quality, proprietary ownership and for fast lead time.