KNOWLEDGE CREATION IN NEW ZEALAND MANUFACTURING

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ABSTRACT

Organisational knowledge creation is a key driver of innovation and competitive advantage. The ability to successfully create new knowledge and embody this knowledge into new products, processes, or services is critical to the ongoing survival of an company. Organisational product development activities and practices interplay with the organisational knowledge base to produce these results. The objective of this research was to investigate the knowledge creation processes and practices utilised by a group of New Zealand manufacturers. A series of in-depth interviews was conducted with senior managers of a group of 33 manufacturing companies in the Wellington and Manawatu regions of New Zealand.

The majority of the companies saw product development as an important organisational activity, but at the same time only half of the companies made use of a formal product development process. The most important and most frequently used product development activities were related to the physical design and manufacture of a product, and on assessing the viability of a product concept in the early development stages. The activities least frequently used were notable in that they all focussed on intangible elements of the product development process, e.g. test marketing, detailed market research and pre-launch business analysis.

Tacit-orientated information sources were identified as being crucial to the companies' overall business activities. Customers, along with personal experience and company staff were identified as the three most important information sources to the companies' overall business activity. Overall the companies placed a greater value on their tacit-based knowledge than their codified knowledge.

The companies were ranked based on the innovativness of their knowledge creation activities. The 33 companies were separated into three groups: highly innovative, moderately innovative and least innovative companies. The knowledge creation processes and activities used by these three groups were explored to identify the characteristics that separated the highly innovative companies from the others. Overall the key distinctions were:

- a greater degree of formal business planning;

- a greater optimism for their company's overall position in five years;
- better utilisation of both internal and external-based tacit knowledge;
- a more strategic approach to information acquisition;
- a greater use of formal product development processes;
- a more intensive product development programme;
- a shorter product development process; and
- better application of the organisational knowledge base for product development activities.

Overall, the highly innovative companies demonstrated a greater willingness to take on the challenge of developing new products and to expanding and growing their markets and their business. Perhaps as much as anything it appeared to be this group's attitude to innovation that separated them from the other companies in the study. The highly innovative companies were less formal in terms of their organisational management systems and practices than the moderately innovative companies in the study, but were achieving far greater levels of product innovation. One point to note is the slightly lower level of reported product success amongst the highly innovative companies. This is likely attributable to the shorter product development process that these companies were using, although this is not conclusive and would require further research.

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1.1 INTRODUCTION

In 1993, Drucker suggested that a new era was beginning, "a knowledge society", where the basic economic resource was no longer capital, nor natural resources, nor labour, but knowledge (Harris, 1993). This statement has more recently been reinforced in a New Zealand context by the Ministry of Research, Science and Technology, which stated that "New Zealand, like other western countries is evolving to become a knowledge society". The Ministry further stated that knowledge is now one of the main drivers of prosperity and well being (Ministry of Research, Science and Technology, 1998).

In this context, both knowledge and information are playing an increasingly active and prominent role in the value creation activities of New Zealand companies. Knowledge is fundamental to an organisation in order to create, produce and market goods and services, to solve problems, to make decisions, and to organise the company. The role of information in the company is to reveal or create new knowledge, to maintain the basic level of knowledge, and to stimulate and increase understanding of the process of human relations, production, technology, organisation and other systems (Kalseth, 1991a). Information is a flow of messages, while knowledge is created by that very information (Nonaka and Takeuchi, 1995).

1.2 PROCESS OF KNOWLEDGE CREATION

Despite this recognition that knowledge is a critical organisational resource, there has been only limited research undertaken on the ways in which organisations create knowledge. The vast majority of the research surrounding the areas of knowledge and information has been premised on the idea that a company is a machine for information processing. This view only recognises the explicit information base of a company, that is information that can be easily codified, and has failed to adequately explain how knowledge is created and the process of innovation (Nonaka and Takeuchi, 1995).

In contrast to this view, Nonaka and Takeuchi (1995) stated that innovation is facilitated by a process of organisational knowledge creation. Information accumulated from the outside is shared widely within the organisation, stored as part of the company's knowledge base, and used to create new knowledge that is then embodied in new products, processes and services. The knowledge base, a key internal resource within this process, has been defined as the absolute collection of all expertise, experience and knowledge that exists within an organisation (Aegiss, 1995). The process of knowledge creation relies on the interaction of two distinct types of knowledge, explicit and tacit knowledge. Explicit or codified knowledge is drawn from information that can be easily codified, catalogued and stored. Tacit knowledge is less tangible, it is highly personal, based on know-how and is hard to formalise or codify (Nonaka and Takeuchi, 1995).

1.3 PROCESS OF PRODUCT DEVELOPMENT

The product development process is central to the creation of new organisational knowledge. How well companies manage their new product development process becomes a critical determinant of successful organisational knowledge creation and consequently the levels of innovation that are achieved (Nonaka and Takeuchi, 1995). The process of product development is best described as "...a formal blueprint, road map, template or thought process for driving a new product project from the idea stage through to market launch and beyond" (Cooper, 1994).

The development of new products (and the creation of new knowledge) is inextricably linked to the concept of innovation. Freeman (1988) defined innovation as "a continuous process of learning, searching and exploring which results in new products, new processes, new organisations, and new markets". Nonaka and Takeuchi (1995) stated that innovation is facilitated by the process of organisational knowledge creation, and product development.

1.4 PROCESS OF KNOWLEDGE CREATION IN NEW ZEALAND

The New Zealand economy has undergone significant change in the last fifteen years. During the mid 1980s, the Government embarked on a series of reforms which saw the economy deregulated and opened up to international competition. These two initiatives significantly changed the nature of competition in New Zealand. Today, successful enterprises are those that are flexible, adaptive, innovative and responsive, with a committed, highly responsive and skilled work force (Australian Manufacturing Council, 1994). Productivity is achieved through people, a manufacturer's most valuable asset. Because of the more challenging competitive environment, New Zealand's manufacturers are now more dependent on their ability to create competitive advantage. Companies are reliant on being innovative, enterprising and responding swiftly to market demands (Statistics New Zealand, 1996).

A number of previous New Zealand studies have looked at research in complementary areas to that of knowledge creation, such as product development processes and practices (Kerr, 1994; Souder et al., 1997); innovation systems (Frater et al., 1995); enterprise information usage (Chalmers, 1994; Gnomes 1998); and the impact of information technology and information management on competitive advantage (Cragg, 1990). No research in New Zealand has studied organisational knowledge creation in a holistic sense. Each of the above studies looked at an element that contributes to the activities and systems that support organisational knowledge creation, but none of the studies drew all of these elements together in a way that provided an overall impression of what drives knowledge creation.

This research investigated the process and practice of knowledge creation utilised by a group of New Zealand manufacturers. Three organisational elements were explored: product development processes and activities; the organisational knowledge base; and the extent to which these interact and impact on the level of product innovation within the organisation. Together these three elements provide an overall picture of organisational knowledge creation.

The manufacturing sector was chosen for this research because a wide spectrum of information (and knowledge) resources is used within the sector (Butterwick, 1994; Kennington, 1989). The manufacturing sector can be split into two areas, primary manufacturing and non-primary manufacturing. Primary manufacturing comprises the meat and dairy processing sectors, while non-primary manufacturing is made up of the following industries: textiles, apparel and leather; non-metallic minerals; fabricated metals; chemical products; basic metals; wood and wood products; paper and printing; and other foods and beverages (Ministry of Commerce, 1996). Knowledge creation activities occur both in the primary and non-primary manufacturing sectors but in recent years the non-primary manufacturing sector has become increasingly important to the overall economy. Over the five year period up to 1994/95 exports in this sector increased by 78%, from $5306m to $9423m, while at the same time exports in the primary sector increased by only 11%, from $3428m to $3809m (Ministry of Commerce, 1996). For this reason the non-primary manufacturing sector was chosen as the focus for this study. A series of 33 in-depth interviews were conducted with senior managers from a group of companies in the Wellington and Manawatu regions during late 1995. A comparison of the responses to these interviews with recent literature on the subjects surrounding the area of knowledge creation formed the basis of this study.

1.5 RESEARCH OBJECTIVES

To date there has been limited research in New Zealand into the relationships between organisational product development activities, the organisational knowledge base and the impacts of these organisational resources and activities on levels of innovation within the New Zealand manufacturing sector. The broad objective of the research was to investigate knowledge creation processes and practices utilised by New Zealand manufacturers.

Specific objectives were to determine:

- The levels of product development processes and practices within the companies.
- The extent of the knowledge bases with reference to product development processes and activities within the companies.
- The levels of product innovation within the companies.

These objectives were combined into the following hypotheses:

H_1 That a positive relationship exists between the level of product innovation and the level of product development processes and activities within the companies.

H_2 That a positive relationship exists between the level of product innovation and the extent of the knowledge base within the companies.

2. Organisational Knowledge Creation: An Overview

2.1 INTRODUCTION

In today's business environment, manufacturers are required to continuously produce innovative new products and services in order to remain competitive. The environment in which companies operate is constantly changing and evolving. Recently the rate of change has been accelerated in a number of areas resulting in a number of direct impacts on the commercial operating environment (Griffin, 1997). Examples of this accelerated change include:

- increased levels of competition (Hayes et al., 1988; Lawrence, 1993; Womack et al., 1990);
- more rapidly changing market environments (Carlson, 1994; Sellers, 1991);
- higher rates of technical obsolescence (Norton and Bass, 1992); and
- shorter product life cycles (Bayus,1994; von Braun,1990).

Consequently, companies need to react to these challenges by implementing changes that both help speed up the processes that drive new product development, and at the same time improve and enhance those very processes. The process of organisational knowledge creation has been recently identified as a key driver of innovation and overall organisational success (Nonaka and Takeuchi, 1996). The new product development process is a core process for creating new organisational knowledge. How well companies manage their new product development process becomes a critical determinant of successful organisational knowledge creation and in turn of the levels of innovation that are achieved (Nonaka and Takeuchi , 1995).

An overview of previous research surrounding the subject of organisational knowledge creation is presented in this chapter. The following topics are covered:

- knowledge and innovation;
- information and knowledge, key resources;

- the theory of organisational knowledge creation;
- product development, the engine of knowledge creation;
- knowledge creation in New Zealand manufacturing; and
- knowledge creation, a key driver of innovation.

2.2 KNOWLEDGE AND INNOVATION

The key determinant of success for an enterprise is its ability to gather and utilise knowledge to drive innovation (OECD, 1996). Knowledge, in the form of technology and market information, has become the principal resource in the world economy, especially knowledge in its dynamic form as the capacity to generate new technologies and to market new products (OECD, 1994a). The most useful information for a company seeking to innovate may exist outside its organisational boundaries. For example, some of the most relevant information for companies seeking to innovate emanates from its suppliers and customers (von Hippel, 1988). What the company does is already supported by its internal information resources. If a company wishes to innovate it must, as well as rearranging or re-deploying existing information, seek out and apply new sources of information from outside of its organisational boundaries (MacDonald and Williams, 1993).

Freeman (1988) defined innovation as "a continuous process of learning, searching and exploring which results in new products, new processes, new organisations, and new markets". It is important to recognise that innovation is not restricted to the areas of new product, service or process development. Innovation can also be applied to organisational structures, work practices and the development of whole new markets (Frater et al., 1995). This study is focused on innovative activity in relation to the management processes and practices surrounding the development of new products, but acknowledges this wider definition.

Within the context of the emerging knowledge-based economy, the traditional linear model of innovation (Figure 2-1) has become less relevant (Klein and Rosenberg, 1986). This model assumed that innovation proceeded as a series of fixed and linear phases. Innovation began with new scientific research, progressed through stages of product development, and terminated with the successful sale of a new product, process or service.

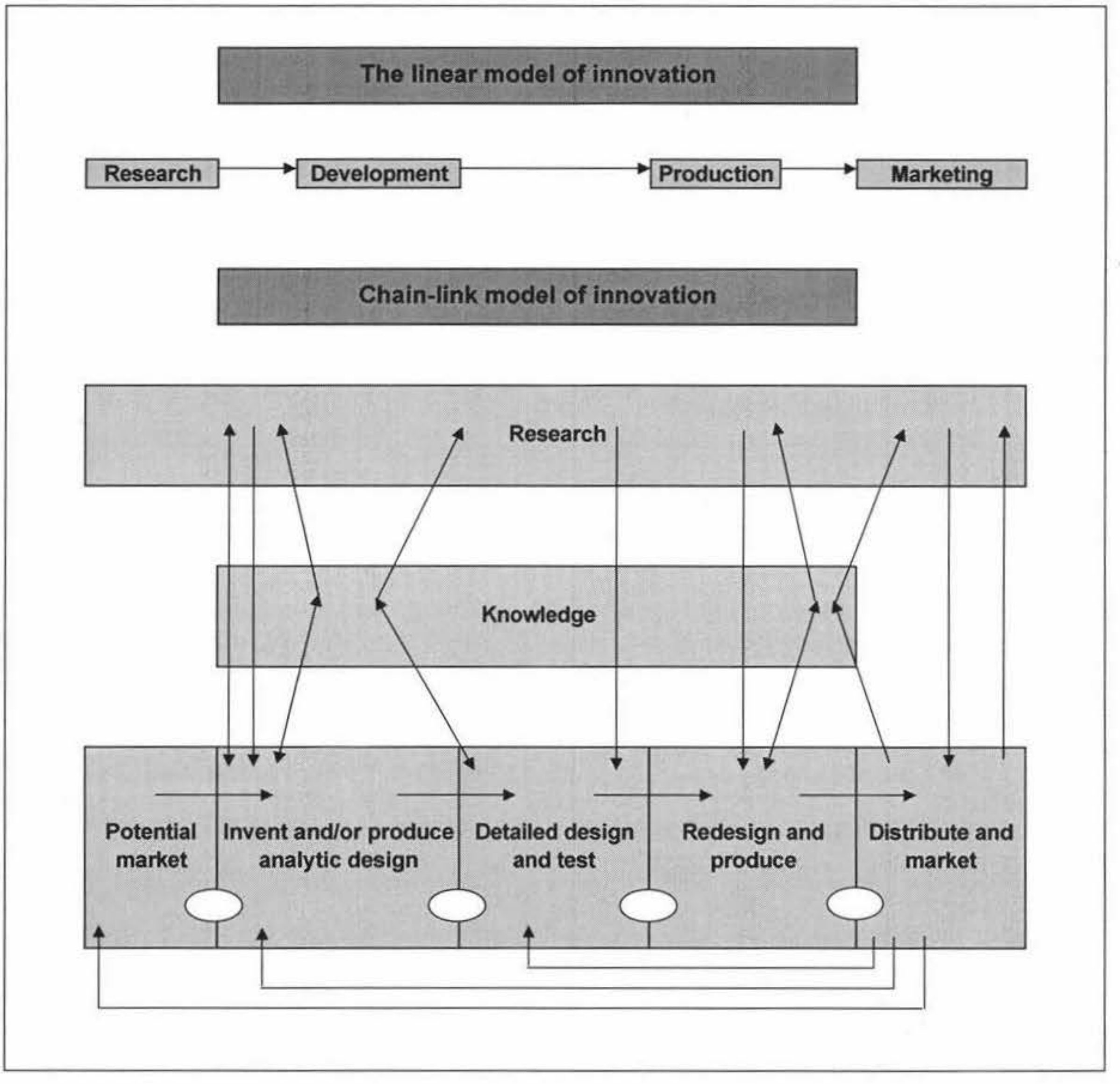

Figure 2-1: Linear and Chain-linked Models of Innovation (Klein and Rosenberg, 1986)

In contrast to this, innovation has more recently been viewed as emerging from multiple sources, in many different forms. In this model the process is not completely linear. The more interactive model requires high levels of communication, within the company, and between the company, its external agencies and customers. The key facilitator of innovation within this model is knowledge (Klein and Rosenberg, 1986).

Nonaka and Takeuchi (1995) contended that current organisational theories did not explain the process of innovation. These theories view the organisation as a mechanism for "the processing of information". When organisations innovate they do not simply process information from the outside; they create new knowledge and information inside the organisation. Today innovation is driven in the majority of cases through a market pull, where perceived customer needs result in focused development programmes to satisfy these needs. This "market pull" model results in a company where employees, "knowledge workers", are the key business assets and the company seeks increased development of its knowledge base, product quality and process productivity through continuous improvement (Frater et al., 1995).

2.3 INFORMATION AND KNOWLEDGE: KEY ORGANISATIONAL RESOURCES

Knowledge is fundamental in an organisation in order to solve problems, make decisions, produce goods and services, and market and sell products. The role of information in this context is to reveal or create new knowledge, to maintain the basic level of knowledge, and to stimulate and increase our understanding of the process of human relations, production, technology, organisation and other systems (Kalseth, 1991b).

Although knowledge and information are often used interchangeably, there is a clear distinction. Information is a necessary medium for eliciting and constructing knowledge. It affects knowledge by adding something to it or restructuring it (Machlup, 1983). Information is a flow of messages, while knowledge is created by that very information (Nonaka and Takeuchi, 1995).

Information and knowledge play an increasingly prominent role in companies' value creation activities. Information is in the process of becoming one of the most important, perhaps the most important, competitive factor that business managers have at their disposal in order to improve market and competitive positioning (Kalseth 1991b).

Dalton (1989) stated that information is the life force for efficient and effective performance in all business sectors. This recognition that information is a valuable resource and as such must be paid for, has gained acceptance in recent years (Rickards, Linn and Best, 1989). In an interview with George Harris in 1993, Peter Drucker suggested that in today's organisation, information is the main tool, but few are information literate. Drucker went on to state that before you can become information literate "you must first learn what you need to know" (Harris, 1993).

No organisation contains any more than a tiny fraction of all the information they require that relates to their business operation. The majority of an organisation's information needs are satisfied through external means and enters through individuals (Allen et al., 1983).

2.3.1 Types of Knowledge

Traditionally organisations have focused on "explicit" knowledge, that is knowledge that can be expressed in words or numbers and easily stored and communicated. Nonaka and Takeuchi (1995) contended that this type of knowledge is only the tip of the iceberg. They viewed knowledge as primarily "tacit" – something not easily visible or expressible. Tacit knowledge is highly personal and hard to formalise, making it difficult to communicate or share. A master craftsman, for example, develops a wealth of expertise, but may be unable to easily define his skill in terms of any scientific principles. Polanyi (1966) defined these two forms of knowledge, tacit knowledge and explicit knowledge, as follows:

- "Tacit knowledge is personal, context specific, and therefore hard to formalise and communicate."
- "Explicit, or codified knowledge, refers to knowledge that is transmittable in formal, systematic language."

By shifting the organisational focus to tacit knowledge, a whole different view of the organisation is created, shifting from a machine that processes information to a living organism.

This focus upon tacit knowledge has two important implications for organisations. Firstly the focus is shifted back towards the individual and their ability to acquire and create knowledge. This refocusing on the individual is reflected in recent literature through the identification of concepts such as the "knowledge worker" (Knight, 1988) and the "information gatekeeper" (MacDonald and Williams, 1993; Tushman and Scanlan, 1981; Tushman and Katz, 1980).

The knowledge worker has been defined as "...someone engaged in work that requires the exercise of considerable judgement and the utilisation of knowledge of a theoretical or practical nature. The knowledge worker can also be characterised as someone producing, applying, advancing or transferring knowledge as a networker, and interfacing complex processes, systems and situations. The primary modes of knowledge work are learning, thinking, reflecting, conversing and other forms of communicating" (Knight, 1998). Knowledge workers are a key source of competitive advantage and wealth creation within the organisation.

MacDonald and Williams (1993) investigated the role of the "information gate keeper" within an organisation. A gatekeeper has been defined as an individual who is both strongly connected to internal colleagues and strongly linked to external domains. Gatekeepers are able to gather and understand external information, and subsequently they translate this information into a form that it is useful to the organisation (Tushman and Katz, 1980). What distinguishes a gatekeeper is their ability to interpret and apply internally the information they gather (Tushman and Scanlan, 1981).

Several studies of innovation, technology transfer and technology diffusion have identified tacit knowledge as an important component of innovation (Dosi, 1988; Rosenberg, 1976, 1982). Imai (1991) proposed that, in a great number of instances information relevant to an organisation's innovation activity exists randomly in society as tacit knowledge. Access to this type of information is mainly through social networks or "know-who".

2.3.2 Acquisition of Information

Information acquisition is a critical organisational activity. Behind a protective shell of current information, companies are more able to withstand the pressures of changing economic conditions and to make the right business decisions (Gelstharp, 1990).

Organisations generally accumulate their information through an ongoing process of absorption. There are complex processes for the acquisition of information that depend on the context and purpose for which information is being gathered. Generally companies make considerable use of informal strategies for information acquisition. There are a number of factors that have been identified (Sharkey, 1992) as influential on a company's information acquisition strategy:

- life cycle stage;
- type of problem/opportunity;
- relationship to customers; and
- time availability.

Organisations gather and access information from a wide range of sources. Butterwick (1994) reported manufacturing organisations drew on a wider range of informational resources than service-based companies. In addition to business information such as finance and management, manufacturing companies sourced information relating to material and labour costs, competitors, materials, product development, machinery and quality. White (1986) found that information acquisition within manufacturing organisations was problem specific, with different sources being drawn upon depending on the nature of the problem. Dealing with an unfamiliar or difficult area created a greater need for information. Research looking at information acquisition processes for a group of manufacturing enterprises has shown that generally these organisations acquire information to meet immediate needs, which are generated by a particular activity or an unforeseen event. There is not a recognised need for the gathering of general information or facts for long term planning (Capital Planning Information Ltd, 1982).

Roberts and Clifford (1986) identified a paradoxical relationship between information needs and information acquisition practices. Respondents indicated that information was a critical organisational resource, while at the same time acknowledging the use of generally casual approaches to its acquisition. Orminski (1991) identified that companies that have well developed business strategies were more likely to have a formalised approach to information gathering and use. Availability of time was also seen as a significant barrier to the acquisition of information (Butterwick, 1994).

2.3.3 Management and Use of Information and Knowledge

With the new importance of both knowledge and information based assets to an organisation, there is a growing recognition of the need to manage and apply these assets for competitive advantage. The strategic use of information, (i.e. planned, goal-orientated and controlled identification, accumulation, processing, diffusion and use and reuse of internal and external information), consequently means that information and knowledge must be evaluated and managed along the same lines as other company resources such as personnel, capital, and methods of production (Kalseth, 1991a).

Knowledge management is an important response to the critical issues of organisational adaptation, survival and competence in the face of continuous environmental change. Essentially, it embodies organisational processes that seek to combine data, information, knowledge, and processing capabilities of information technologies, with the creative and innovative capacity of human beings (Malhotra, 1997). A critical element of an organisation's knowledge management activities is the organisational knowledge base. The knowledge base has been defined as the absolute collection of all expertise, experience and knowledge that exists within the organisation (Aegiss, 1995). The knowledge base consists of both tacit and explicit knowledge resources.

2.3.4 Information and Information Technology

An organisation that has the ability to store and retain its knowledge base for later utilisation will be able to make more effective decisions in response to an ever-changing global business environment (Aegiss, 1995). An important tool for the management and the use of an organisational knowledge base is information technology. However, the importance of information technology has often been over-stated. Peter Drucker pointed to the fact that currently there is too great a focus on information technology by those seeking to create competitive advantage. He stated that it is too easy to confuse data with knowledge and information technology with information (Harris, 1993). Rather than focus on the competitive advantage that can be gained through the use of information technology, it would seem more appropriate, from an organisational point of view, to focus on gaining competitive advantage through the intelligent application of information and knowledge (Cragg, 1991).

Information is data we perceive, understand and put together as knowledge. Information technology is a tool we use to gather, process and distribute information (Kalseth, 1991b). Successful use of information and knowledge demands that companies incorporate an information strategy in their business strategy. Emphasis must be placed on information content (strategic information) and on effective information organisation. Technology must be seen as a tool and not assigned the status of a solution (Kalseth, 1991b).

2.4 THEORY OF ORGANISATIONAL KNOWLEDGE CREATION

In 1995 Nonaka and Takeuchi proposed a theory to explain the knowledge creation process within an organisation. In their book *The Knowledge Creating Company* they argued that the success of Japanese companies, in the recent past, had been due to their skill and expertise in "organisational knowledge creation". Their model (Figure 2-2) presents a two dimensional approach to organisational knowledge creation. On the vertical axis is the "epistemological dimension" (this describes the type of knowledge that exists within the organisation) where a distinction is made between explicit and tacit knowledge. On the horizontal axis is the "ontological dimension" of knowledge creating entities (e.g. individual, group, organisational and intra-organisational entities).

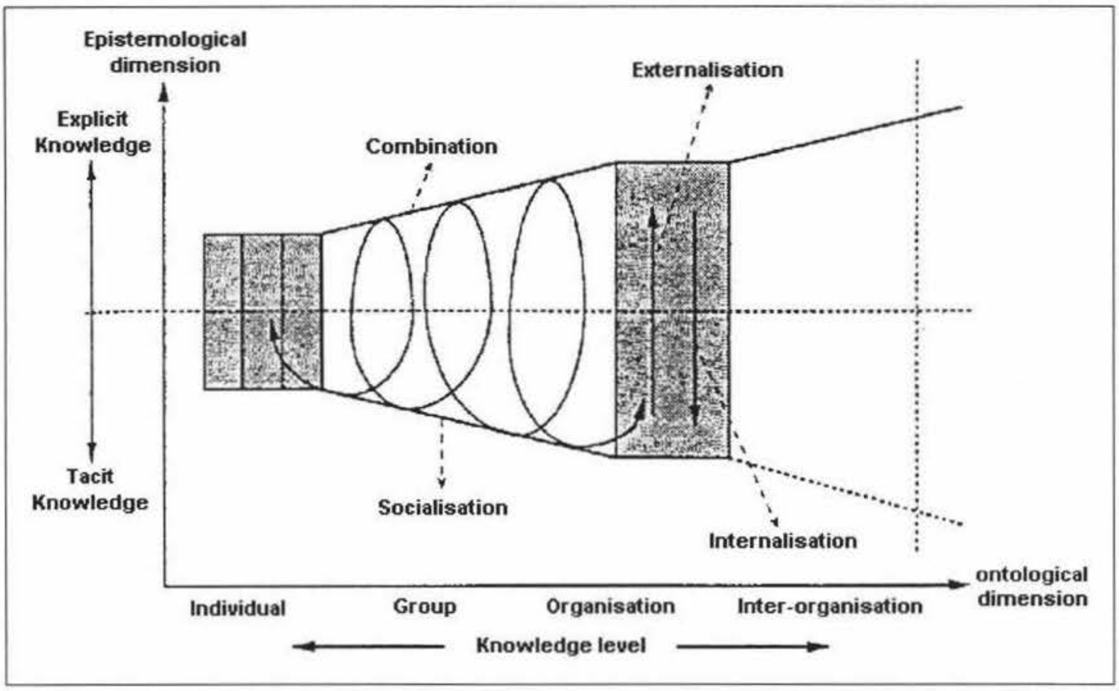

Figure 2-2: Spiral of Organisational Knowledge Creation (Nonaka and Takeuchi, 1995)

In relation to the ontological dimension the model recognises that an organisation cannot create knowledge, individuals create knowledge. The organisation provides the support and a context for this knowledge creation. Organisational knowledge creation can best be described as the process that organisationally amplifies the knowledge created by individuals and crystallises it as part of the knowledge system of the organisation. (Nonaka and Takeuchi, 1995)

2.4.1 Knowledge Conversion: Interaction between Tacit and Explicit Knowledge

At the centre of organisational knowledge creation is the process of knowledge conversion. The interaction between tacit and explicit knowledge provides the basis for knowledge conversion (Nonaka and Takeuchi, 1995). There are four modes of knowledge conversion. These are outlined in Table 2-1.

Table 2-1: Modes of Knowledge Conversion (Nonaka and Takeuchi, 1995)

Socialisation: Tacit – Tacit.
This process refers to the sharing of experiences resulting in the creation of knowledge. It is the acquisition of knowledge from others through observation and shared experience, e.g. an apprentice learning a craft from a master craftsman. This mode creates a common dialogue between individuals and triggers the second mode, externalisation.
Externalisation: Tacit – Explicit.
This is the process of transforming tacit knowledge into an explicit form. This new knowledge may take the form of metaphors, analogies, or concepts. This process is used frequently in the process of product concept creation.
Combination: Explicit – Explicit.
This mode of knowledge involves combining bodies of explicit knowledge into a knowledge system. Combination is triggered through the interaction of this new knowledge with knowledge that exists within the organisation. The reconfiguration of existing information by sorting, combining, adding or categorising explicit knowledge can lead to the creation of new knowledge. Most formal education takes this form.
Internalisation: Explicit – Tacit.
This process involves embodying explicit knowledge into tacit knowledge. Learning by doing triggers this final mode. When experiences through socialisation, externalisation and combination are internalised into individuals' tacit knowledge bases in the form of shared mental models or know-how, they become valuable assets. For organisational knowledge creation to take place the tacit knowledge accumulated at an individual level has to be socialised, thereby starting a new spiral of knowledge creation.

2.4.2 The Knowledge Spiral

The tacit knowledge of individuals forms the basis of organisational knowledge creation. This tacit knowledge is amplified through the four modes of knowledge creation in what has been called the knowledge spiral (Nonaka and Takeuchi, 1995), this is shown in Figure 2-3. Tacit and explicit knowledge interact to create innovation. Organisational knowledge creation is a continuous and dynamic interaction between tacit and explicit knowledge (Nonaka and Takeuchi, 1996). The knowledge spiral moves through the ontological levels of the organisation, starting at an individual level and moving through expanding communities of interaction.

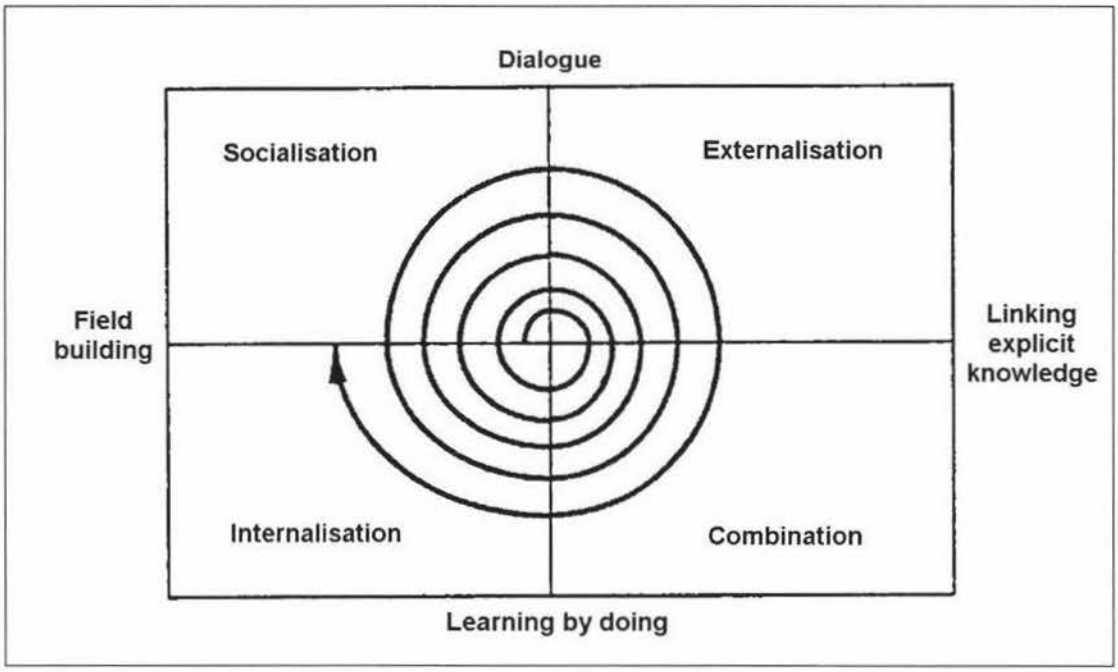

Figure 2-3: The Knowledge Spiral (Nonaka and Takeuchi, 1995)

2.5 PRODUCT DEVELOPMENT: THE ENGINE OF KNOWLEDGE CREATION

The process of knowledge creation is exemplified by product development. Creating a product involves a community of individuals, from both within and outside the company. As a concept evolves, it progresses through the knowledge spiral and at the same time advances through the levels of the organisation. The end result is a new product, process or service, and an increase in the knowledge base of the company. How well companies manage their new product development process becomes a critical determinant of how successfully organisational knowledge creation can be carried out (Nonaka and Takeuchi, 1995). Product development activities should be seen as a knowledge creation process, which through the commercialisation of a product, ties together the knowledge base that exists as both an internal and an external resource of the company (Nagata et al., 1994).

2.5.1 The Product Development Process

It was not until the late 1960s that a detailed study of product development practices was first undertaken. The study was conducted by Booz-Allen and Hamilton and sought to identify current product development practices used within companies. Their research concluded that the use of a formal process provided management with a series of activities that could be followed to create a product that had a greater chance of success. A second conclusion followed that the use of a systematic process allowed for a greater degree of planning and a better control of resources (Booz-Allen and Hamilton, 1968).

Since that time a number of formal processes have been proposed as examples of best practice methodologies for new product development activities. Over the past 30 years the trends in new product development activity have been more evolutionary than revolutionary. The process of new product development is a complex activity involving many people across many functional areas of an organisation. However, one thing is certain, if organisations are not constantly reviewing their product development practices and policies then they will find themselves falling behind (Griffin, 1997).

Over that period, companies have changed from functional and sequential approaches to new product development to multi-functional approaches with formal stages and gates for moving from one activity to the next. A "stage gate" model (shown in Table 2-2) for this process was first proposed in 1986 by Cooper and Kleinschmidt. Their study proposed 13 activities in the new product development process and was based on both normative and empirical descriptions from previous research by Myers and Marquis (1969), Little (1970), Unnerback et al. (1976), Rothwell (1972), Booz-Allen and Hamilton (1982) and Cooper (1983).

The Cooper and Kleinschmidt model was chosen as the methodological model for this study because it had been used in comparable national and international studies. In 1991, a study of product innovation management in Spain was undertaken by Sanchez and Elola, and in 1994, a New Zealand based study of product development practices in small manufacturing companies was undertaken by Kerr. Both these studies made use of Cooper and Kleinschmidt's 13-activity process model.

Table 2-2: Product Development Process (Cooper and Kleinschmidt, 1986)

Initial screening	*The initial go/no go decision. It is first decided to allocate funds to a proposed product idea.*
Preliminary market assessment	*An initial, preliminary appraisal of the market for the product. A first and quick look at the market.*
Preliminary technical assessment	*An initial, preliminary appraisal of the technical side of the project. A quick evaluation of the technical feasibility of the product.*
Detailed market study/ Market research	*Market research involving a reasonable sample of respondents, a formal design, and a consistent data collection procedure.*
Business/Financial analysis	*A financial or business analysis leading to a go/no go decision*
Prototype development	*The design and development resulting in a prototype*
In-house testing	*A test of the product in-house, as opposed to in the field or with customers*
Consumer testing	*A test of the product under real life conditions.*
Test market	*The selling of the product to a limited set of customers*
Trial production	*A trial run to test production facilities*
Pre-launch business analysis	*Financial analysis prior to full-scale launch*
Production start-up	*The start-up of full-scale or commercial production*
Market launch	*The launch of the product on a full-scale commercial basis*

The Cooper and Kleinschmidt model does however have its limitations, acknowledged in 1994 by Cooper:

- projects are assumed to follow a linear path;
- the single product focus may not lead to project prioritisation and focus;
- some activities are spelled out in far too much detail; and
- the process might be seen as bureaucratic and non-adaptive.

These points would seem to indicate that although the 13-activity model provides a framework there is still a great deal of skill needed in its manipulation and application on a project-by-project basis.

2.5.2 Advantages and Benefits of a Formal Product Development Process

Research to date has clearly identified a number of advantages and benefits that can be gained from following a formal product development process. A summary of these benefits is given below:

- early entry into large and growing markets (Zirger and Maidique, 1990);
- a greater likelihood of launching a successful product (Booz-Allen and Hamilton, 1982; Cooper and Kleinschmidt, 1991);
- a more multidisciplinary approach to product development, incorporating both technical and marketing inputs ensures a greater likelihood of success (Cooper, 1983; Cooper and Kleinschmidt, 1991);
- incremental feedback and check points to allow continual monitoring of the process. This results in earlier feedback on product failures (Cooper, 1983; Cooper and Kleinschmidt, 1991);
- a more market orientated development process (Cooper, 1983);
- the requirement for less rework within product development activities (Cooper and Kleinschmidt, 1991); and
- the shortening of development time for a product (Cooper and Kleinschmidt, 1991).

Despite the proven nature of applying a formal process to the activity of product development, research has shown that many companies are implementing only minimal product development processes. In New Zealand, Kerr (1995) conducted a study of product development practices in a group of 84 small and medium sized enterprises. The results were consistent with overseas research conducted by Cooper and Kleinschmidt (1986), Sanchez and Eloa (1991) and Mahajan and Wind (1992). All four studies found that in the majority of cases a truncated product development process was applied, with between 8-9 of the 13 activities usually being undertaken.

There was generally a greater focus on the tangible, product-focused activities of the development process.

2.5.3 Management of Product Development Activities

The adoption and use of a formal process approach to the development of new products is not enough to ensure the success of a product. There are a number of organisational elements that contribute to the overall success of a company's product development activities. A key element in the recognition and application of a systematic product development process is the attitude and support of senior management. The attitudes of management to product development impact on activities undertaken, the processes that are followed and the resources that are committed to the project. The benefits of management commitment are:

- a greater chance of successful product development outcomes (Booz-Allen and Hamilton, 1968);
- a greater strategic orientation and focus (Feldman and Page, 1984; Zirger and Maidique, 1990); and
- a greater profile and commitment within the company for product development (Johne and Snelson, 1990).

The importance of strategic planning to the process of product development has also been identified by a number of authors (Alder et al.,1989; Cooper and Kleinschmidt, 1991; Crawford, 1983). A comprehensive organisational level strategy provides a framework to guide product development activity in a way that is consistent with the future direction of the company, in terms of technology and markets, priorities and capabilities.

Another key element of the organisational mix is the management structure and technique that is used to manage the process of product development. A variety of approaches are used by companies. The most common structure used by companies to manage innovative product development projects is the functional organisation, i.e. product development activity is organised around organisational functions. The use of this type of approach is at odds with the abilities of this type of organisational structure to promote cross-functional communication and the open exchange of ideas (Souder, 1987). The use of multidisciplinary teams within the functional environment has become more popular in recent times. Product development is a cross-functional exercise, and can involve personnel from every functional specialisation within the organisation. It is therefore best organised around a multi-functional core team (Jenkins et al., 1997).

Nonaka and Takeuchi (1995) proposed a management theory in which middle management within an organisation synthesises the tacit knowledge of both senior management and front line employees, making it explicit and facilitating its incorporation into new technologies, products and processes. This theory was titled "middle up-down management".

It is important to note that the use of a structured approach to product development is not a guarantee of success. All methodologies currently in use have potential weaknesses of which corporate managers must be aware. The models of product development identified in academic literature should be viewed as guidelines, not as strictly defined set of rules (Jenkins, 1997).

2.6 KNOWLEDGE CREATION IN NEW ZEALAND MANUFACTURING

There has yet to be a comprehensive review of knowledge creation processes and practices carried out in New Zealand's manufacturing sector. There have been a number of previous research studies undertaken in the three organisational areas surrounding the topic of knowledge creation: product development processes; the organisational knowledge base; and the extent to which these interact and impact upon the level of product innovation within the organisation.

2.6.1 The New Zealand Manufacturing Environment

New Zealand's manufacturing sector is characterised by a large number of small and medium sized enterprises (SMEs) as shown in Table 2-3. By far the majority of New Zealand companies (approximately 96%) employ less than 50 people.

Table 2-3: Size of Companies in the NZ Manufacturing Sector

Number of employees	0-9	10-49	50-99	100+	Total
No. of Companies	16,941	3,716	507	421	21,585
% of Companies	78.5%	17.2%	2.3%	2.0%	100%

There is a wide range of sector and governmental based organisations and agencies that provide support for knowledge creation activities to the manufacturing sector. These include Crown Research Institutes, research associations, universities and polytechnics. In addition there is a significant network of organisations and groups from which manufacturing companies draw information and ideas, including: customers; suppliers and sales representatives; trade associations and professional bodies; libraries; media; trade journals; exhibitions and tradeshows; conferences; consultants; friends and family; other companies and competitors; patent information; information brokers; and on-line sources.

In 1995, when this research was undertaken, there were a number of government interventions aimed at enhancing the ability of companies to grow. These included:

- the Business Development Boards, a network of independently run agencies that sought to raise the capability of companies to innovate by increasing their business skills and abilities;
- the Technology for Business Growth scheme, which focussed on increasing the ability of New Zealand companies to apply technological innovation for business growth by providing matched funding for product development projects to be undertaken, either by the company alone, or by a company in partnership with a technology provider; and
- the New Zealand Trade Development Board that provided a range of support services to the enterprise sector and dedicated to raising the sector's ability to successfully develop products for export. In addition to these government initiatives a number of regional based enterprise agencies provided assistance to their local business communities.

2.6.2 Organisational Product Development in New Zealand

Research has shown that product development, which has been described as the engine of knowledge creation (Nonaka and Takeuchi, 1995), has been recognised an area of growing importance within New Zealand's manufacturing enterprises. In a recent survey of 30 of New Zealand's leading manufacturing exporters (Informetrics, 1995), product development was identified as the area that attracted the highest level of investment-based spending, at 22%. In a broader study, Frater et al. (1995) surveyed 730 manufacturing enterprises and found that 38% intended to expand their product range over the next five years. This was compared to only 11% in a similar study carried out in 1992 by Corbett. These statistics indicate that the need for a systematic approach to product development has gained wide acceptance in New Zealand's manufacturing sector.

In 1994 Kerr conducted a comprehensive study into current product development practices in a group of 84 small New Zealand manufacturing companies. He concluded that the product development processes used by these companies were truncated in relation to Cooper and Kleinschmidt's 1986 product development model, with the average company performing between eight and nine of these activities. He also identified the crucial role of management in ensuring the overall success of the product development activity. Kerr concluded that the companies in his study were producing only moderate results from their product development activities in terms of product success, innovativeness, the numbers of new products being introduced, and overall company growth. He concluded that over-simplistic product development methods and resources were preventing companies from fully realising their potential for innovation. In a more recent study Souder et al. (1997) compared a group of American high technology companies with a similar group from New Zealand. They concluded that overall the New Zealand companies had higher levels of performance in relation to new product development activity. In particular the integration of marketing activities into the development process and a higher level of customer focus by the New Zealand companies set them apart. It is important to note that a "small" company in this study was defined as a company that had less than 500 employees. In the New Zealand context the more accepted definition of a "small" manufacturing enterprise is one that has less than 50 employees (Devlin, 1984).

2.6.3 The Organisational Knowledge Base in New Zealand Manufacturing

In relation to information needs of New Zealand companies, Chalmers (1994) investigated the business information needs of a group of 27 managers from eight companies involved in exporting or tourism. The information needs of these companies spanned a wide spectrum of information sources, and the majority of respondents reported an *ad hoc* approach to the assessment and management of information within their organisations. The majority of organisations studied lacked an infrastructure for proactive information management.

2.7 KNOWLEDGE CREATION: A KEY DRIVER OF INNOVATION

The activity of knowledge creation has been identified as a key driver of product innovation (Nonaka and Takeuchi, 1995). This study aims to explore the knowledge creation activities of a group of New Zealand manufacturing organisations. This literature review has identified three streams of scholarship that can be drawn on to build a comprehensive picture of organisational knowledge creation.

- The extent of the knowledge bases with reference to product development processes and activities within companies.
- The levels of product development processes and practices within companies.
- The levels of product innovation within companies.

In combination, a greater understanding of how these elements interact will lead to a greater understanding of the process of organisational knowledge creation.

The Organisational Knowledge Base

One aim of this study was to build a picture of the extent and scale of the organisational knowledge base within the companies. The relative importance of tacit and codified sources of knowledge were investigated, both in terms of their impact on overall business activity and also in relation to their impact on product development activities. The information acquisition behaviours of the organisations, the information technology systems, and the management and production systems that existed in the companies were also investigated.

Product Development Processes and Activities

Product development has been described as the engine of knowledge creation (Nonaka and Takeuchi, 1995). The second aim of the study was to build an overall picture of the product development practices and activities of the companies. Cooper and Kleinschmidt's 1986 13-stage model was chosen for this study. This model was useful because there have been a number of comparable studies done, including Kerr (1994), and Sanchez and Elola (1991).

Product Innovation

The relative levels of product innovativeness of the companies was also explored. The basis for this investigation was a study of New Zealand's innovation environment that was undertaken in 1995 (Frater et al.). This study utilises the methodology of that earlier research to construct an innovation index. Using this index the key elements that distinguish the highly innovative companies from the other in the sample were explored.

3. METHODOLOGY

3.1 INTRODUCTION

The literature review presented in the previous chapter clearly demonstrated the increasing importance of information, knowledge, and the process of knowledge creation to the activities of product development and innovation within businesses. Within that context, this research investigated the processes and practices of organisational knowledge creation utilised by a group of 33 New Zealand manufacturing enterprises. Three organisational elements were explored: product development processes and activities; the extent of the knowledge base within the organisations; and the degree to which these interact and impact upon the levels of product innovation within organisations. Due to the emerging nature of the subject of knowledge creation, this study was concerned with exploratory research into these areas.

The primary research element of this study consisted of a series of 33 in-depth interviews conducted with senior individuals from a group of 33 manufacturing companies in the Wellington and Manawatu regions. These interviews were carried out over a three-week period in November of 1995. On-site visits were made for each interview, which typically lasted one-and-a-half hours.

The methodology for this research is derived from a number of previous studies (Butterwick, 1994; Chalmers, 1994; Cooper and Kleinschmidt, 1986; Cragg, 1991; Frater et al., 1995; Kerr, 1994; Roberts and Clifford, 1986; Sharkey, 1991). The multi-disciplinary nature of the topic of knowledge creation meant that a combination of research methodologies was used.

3.2 SAMPLE SELECTION

The non-primary manufacturing sector was chosen for this research because a wide spectrum of information (and knowledge) resources are represented and used within the sector (Butterwick 1994, Kennington 1989). Three industry areas within the non-primary manufacturing sector were selected: companies engaged in producing commercial or building products; companies engaged in producing consumer products; and companies engaged in producing industrial products. An initial sample of seventy companies were selected from the *New Zealand Business Who's Who* (1995). This sample was based on a subjective analysis. Companies that were likely to be engaged in each of the three selected areas were identified by the author from the *New Zealand Business Who's Who* company outlines. The sample of companies selected were limited, due to cost constraints, to the Wellington and Manawatu regions.

A letter of introduction was sent to the Chief Executive or Managing Director of each of the 70 organisations, 33 of whom agreed to participate in the study. These individuals were chosen because of their likely overview of the information needs and development activities within their organisations. For some of the larger companies, managers nominated a more appropriate individual to participate in the interview. The introductory letter was followed by a phone call approximately a week after receipt. The purpose of this phone call was to confirm that the individuals were willing to participate and then to arrange a suitable time for the interview to take place. Overall there was a positive response to this approach, with the initial letter providing a valuable basis for introducing the purpose and context of the study when the follow-up phone call was made.

3.3 INTERVIEW TECHNIQUE

A face-to-face, semi-formal, questionnaire-based interview structure was chosen. This technique was chosen due to the exploratory nature of the research topic. The technique also provided the opportunity for exploration of issues and clarification of concepts with each of the respondents. Each interview lasted approximately lasted one-and-a-half hours and was conducted by the author.

Two pilot interviews were conducted; these interviews resulted in a number of minor modifications to the questionnaire. The minor nature of the modifications meant that the results from these pilot questionnaires were incorporated into the final set. The general response from the interviewees to the interview technique was very positive.

The respondents were encouraged to talk freely about the topics being discussed. A mixture of both open- and closed-ended questions was used. Extensive use was made of show cards. For a number of the questions, a 5-point rating scale was used to allow respondents to indicate an importance rating. In all cases, 1 was not important and 5 was vitally important. The interview was generally very informal in nature with the discussions nearly always exploring certain issues in greater detail. These were recorded as part of the open-ended analysis. One drawback with this technique was the substantial time required to accurately codify the interview results.

3.4 QUESTIONNAIRE DESIGN

The questionnaire was split into the four sections. The first section, organisational activity measures and demographics, sought to gather information to build a general picture of overall organisational health and business activity. The second section explored product development activities within the companies. The third section sought to explore the overall extent and scope of the organisational knowledge base. The final section focused on gathering information on respondent demographics. A copy of the final questionnaire is included in Appendix 1.

3.4.1 General Organisational Activity Measures and Demographics

A range of organisational information was gathered. The information sought included: business focus; age of the organisation; number of employees; functional areas of the organisation; numbers of technically qualified employees; export activities; business planning activity; profit levels; management structure; quality management systems;

and asset rankings. In later chapters some of these measures have been used as indicators to provide an overview of the organisational knowledge base (consisting of both tacit and codified knowledge) as it related to product development activities within the companies that participated in the study.

3.4.2 Product Innovativeness

A set of measures, drawn from an investigation of New Zealand's innovation environment by Frater et al. (1995) were utilised in this study . Frater et al.'s study sought to build a comprehensive picture of the key stakeholders within New Zealand's national innovation system.

The following measures were identified as those relevant to the area of product innovation: projected export growth over the next five years; the number of new and significantly improved products introduced in the past five years; the proportion of annual sales generated by completely new and significantly improved products introduced over the last five years; the extent of change in basic technologies in production processes in the last five years; the extent of change in management, marketing support and related systems in the last five years; the comparative level of plant and equipment in relation to the best international technology and the success of new products introduced in the past five years. The questions on export growth and product success were additions to the measures used by Frater et al. (1995). These additions reflect the focus on the study on product based innovation activity.

3.4.3 Organisational Product Development Activities

A range of questions were asked in relation to the product development activities of the organisation. The first set of questions sought to build an overall picture of the organisation's product development practices. These measures included: importance of product development to the organisation; use of a formal process; sources of new product ideas; responsibility for management of new product development; main problems/barriers that inhibit product development activities; and factors needed to encourage product development.

After describing their own organisation's product development process respondents were presented with Cooper and Kleinschmidt's (1986) 13-activity product development process. The activity of detailed design was added to the original set of 13 activities. This described the activity where the detailed product specifications and designs were produced. The Cooper and Kleinschmidt (1986) process did not incorporate this element. This addition was made by the author to investigate the information resource needs for this activity in relation to the overall process of product development. The activities in this process are outlined in Table 3-1. Respondents were asked to rank each of the activities on a scale from 1-5, 1 being not at all important and 5 being vitally important, in terms of its importance to the company's product development programme.

Table 3-1: Product Development Activities

Initial screening
Preliminary market assessment
Preliminary technical assessment
Detailed market research
Financial feasibility study
Prototype design
In-house testing
Consumer testing
Detailed design*
Trial production
Test market
Pre-launch business analysis
Production start-up
Market launch
** Author's addition to Cooper and Kleinschmidt's 1986 process*

3.4.4 The Organisational Knowledge Base

The aim of this section was to build a picture of the organisational knowledge base in relation to the companies' product development activities. Questions were directed towards information acquisition, relative importance of information resources; and information technology sophistication and usage.

A number of the questions in this section were orientated around the set of information sources outlined in Table 3-2. Each source was classified according to the relative mix of tacit and codified knowledge transfer that is required to create knowledge during the process of product development.

Table 3-2: Information Sources Used in the Study

Tacit Sources
Company staff
Personal experience
Mix of Tacit and Codified Sources
Business consultants
Customers
Exhibitions/Trade material/Conferences
Family & friends
Government agencies
Other companies/competitors
Suppliers/Sales representatives
Trade associations/Professional bodies
Codified Sources
In-house sources
Information brokers
Libraries
Media
On-line sources
Patent information
Trade journals

These information sources were drawn from a number of previous studies (Butterwick 1994, Chalmers 1994, and Frater et al., 1995). These sources were investigated in the following contexts: method of acquisition (formal and/or informal); importance to overall business activity; and usage in relation to product development activities. In addition, the responsibility for sourcing information within an organisation, the percentage of time spent gathering information and the modes by which information enters an organisation were also investigated.

In relation to information technology, the following areas were investigated: understanding and use of the Internet, information management practices (this included non-information technology management practices), and the application and use of information technology within the organisation.

The final part of this section sought to explore the relationship between the information sources and 14-activity product development model. Respondents were first asked to identify the relative use of each of the information sources in relation to their organisation's product development activities. The respondents were then asked to identify the information sources they used for each of the 14 identified product development activities.

3.4.5 Respondent Demographics

Demographic information was provided by respondents; including gender, position, age, ownership stake in company, proportion of time spent on the "workshop floor", and education.

3.5 DATA ANALYSIS

Although the data collected elicited the responses of individuals, the data was used in summary form only. Because of the limited sample size, 33 companies, the results of this research are only descriptive in nature. A large amount of the information collected was in the form of open-ended questions. This information required subsequent classification in order to allow for coherent reporting of results.

3.5.1 Data Analysis Tools

The data was analysed using Microsoft Excel. Before the opened-ended questions could be analysed they were manually collated and sorted into discrete categories, based on a qualitative analysis of the results.

Averages and frequencies were calculated where appropriate. There were no significance tests completed in relation to the results. The fact that the conclusions are based on such a small sample should be recognised as a limitation of this study.

3.5.2 Construction of an Innovation Index

A factor analysis on a selected number of questions in the study was used to construct an "innovation index". The purpose of this index was to rank the 33 companies in terms of their innovativeness in relation to their knowledge creation activities. Eight variables were identified as being indicators for innovative performance. The methodology and variables used for the analysis are based on a 1995 study undertaken by Frater et al. of New Zealand's innovation environment. It is important to note that the eight variables chosen do not represent a comprehensive overview of company innovation, rather the aim of the index was to provide a partial picture of overall company innovativeness in order to explore any difference in other aspects of the companies' knowledge creation processes and activities. The eight variables* used in the factor analysis are outlined in Table 3-3.

Table 3-3: Survey Questions Used to Construct the Innovation Index

Q No.	Question
Q20.	Company growth in next five years in terms of exporting. #
Q21.	Number of completely new products introduced in the last five years.
Q22.	Number of significantly improved products introduced in the last five years.
Q23.	Proportion of annual sales generated by completely new and significantly improved products introduced over the last five years.
Q24.	Success of new products introduced by the company in the last five years. #
Q25.	Extent of change in basic technology in the production processes over the last five years.
Q26.	Extent of change in management, marketing, support and related systems over the last five years.
Q27.	Comparison of plant and equipment with best available technology.

* *The eight variables used here differ from the variables used by Frater et al., (1995). This difference reflects the focus of this study on product development and knowledge creation. The two variables marked with # are additions.*

All 33 companies completed the eight questions. The responses to these questions were used in a factor analysis to construct the innovation index. The factor multipliers used to calculate the innovation index rating for each of the companies are presented in Table 3-4. For each of the companies the normalised value for each question was multiplied by that question's index score and the loaded scores for all the questions were then added together. Based on their innovation index score the companies were then ranked and divided into three groups. The companies in the top third were classified as the highly innovative companies, the middle group were classified as the moderately innovative companies, and the bottom third were classified as the least innovative companies.

Table 3-4: Innovation Index Variable Multipliers

Innovation Index Variables	Factor Multiplier
No. of new products - last 5 yrs.	0.74
Proportion of sales from new products and improved products	0.52
Comparative status of plant equipment with best technology	0.50
Change in production processes – last 5 yrs.	0.49
Success of new products over last 5 yrs.	0.48
Change in mgmt, mrkting and support systems - last 5 yrs.	0.46
No. of improved products – last 5 yrs.	0.37
Export growth – next 5 yrs.	0.33

3.6 CHARACTERISTICS OF COMPANIES IN THE SAMPLE

3.6.1 Market Focus

The 33 companies that participated in the study produced products orientated towards three markets: consumers; industrial users; and commercial or building users. Just under half of the companies, 46% (14) were involved in manufacturing products aimed at the commercial or building sectors. A total of 33% (11) manufactured products aimed at consumer markets, and 21% (7) manufactured products for industrial markets. All the companies were limited liability organisations.

3.6.2 Company Size

A breakdown of the companies that participated in the study is shown in Table 3-5. In comparison to the total population of manufacturing enterprises within New Zealand (21,585 companies, Statistics New Zealand, 1996) the surveyed organisations had a greater representation of companies with more than 10 employees. This over-representation, 84.8% in the survey compared to an overall representation in the population of 21.5%, is based on the assumption that enterprises with greater than 10 employees would be more likely to be engaged in knowledge creation based activities.

This type of sample bias had been previously utilised for similar reasons by Frater et al. (1995).

Table 3-5: Sizes of Companies in the Sample

Company size (No. of employees)	Sample % (No.)	NZ's Manufacturing Sector
0 - 10	15% (5)	78.5%
11 - 49	45% (15)	17.2%
> 50	40% (13)	4.2%
Total	**100% (33)**	**100%**

3.6.3 Company Age

The age of the companies in the study varied widely as shown in Table 3-6. The average age was 27 years. The majority of companies in the study, 78.8% (26), had been operating in their current form for greater than 10 years.

Table 3-6: Ages of Companies in the Sample

Age of Company	% (No.)
< 5 years	12% (4)
6 – 10 years	9% (3)
11 - 20 years	30% (10)
21 - 30 years	9% (3)
31 - 40 years	21% (7)
> 41 years	18% (6)
Total	**100% (33)**

3.6.4 Company Profit

Net profit before tax figures were collected from 81% (27) of the companies; the remaining companies either refused to supply or could not provide the information. Just over half, 52% (14), of those companies that did supply profit information had profit levels above $500,000. Table 3-7 shows the total spread of profit levels amongst all the companies surveyed.

Table 3-7: Profit of Companies in the Sample – Last Financial Year

Profits of the companies	% (No.)
$0 - $49,000	12% (4)
$50,000 - $99,000	9% (3)
$100,000 - $499,000	18% (6)
$500,000 - $1,000,000	18% (6)
> $1,000,000	24% (8)
Refused/Not available	18% (6)
Total	**100% (33)**

3.6.5 Export Focus

The vast majority of companies, 85% (28), were involved in exporting. The main markets for those 28 companies involved in exporting were Australia, 93% (26); Asia (including Japan, China, and South East Asia) 44% (12); America, 25% (7); Europe, 18% (5); and the South Pacific region, 18% (5). Although a high percentage of companies were involved in exporting, the actual percentage of production being exported was low. Just over half, 54% (15), of companies exported less than 10% of their total production. Only 14% (4) of the companies exported greater than 50% of their production.

3.6.6 Validity of the Sample

The sample provided a fair representation of companies from New Zealand's manufacturing sector. The over representation of companies with greater than 10 employees is consistent with previous methodologies (Frater et al. 1995) and aimed to provide a sample of companies that were more likely to be engaged in knowledge creation activities.

3.7 RESPONDENT DEMOGRAPHICS

A total of 53% (17) of the respondents owned the business, while the remaining 47% (16) were employees. The majority, 67% (23), held controlling positions within the company (e.g. a manager or a director). The remaining respondents held senior management positions. On average the respondents spent the majority, (77%), of their time actually managing the business. The remaining 23% of time was spent on the shop floor. All respondents were male, and the majority, 85% (28), were aged between 31 and 60. The majority of respondents, 85% (30), held a tertiary qualification, either trade or university based. Of those only 6% (2) held a postgraduate qualification. The average time spent gathering information by the respondents was 21% of their total time.

3.8 RESEARCH OUTLINE

Presented below is an outline of the remaining chapters in this thesis:

- Chapter 4, The Organisational Knowledge Base, explores a series of attributes and measures surrounding the knowledge base of the companies that participated in the study. The chapter is split into four parts. The first provides an overview of organisational management and production practices, the second explores the range of information technology resources, the third investigates the information and knowledge resources within the companies, and the final section presents a summary of the knowledge bases that exist within the companies.
- Chapter 5, Organisational Knowledge Creation, explores the attitudes of respondents to product development and the importance of product development activities in their companies. It also investigates the relative importance and use of various information sources in relation to product development activities. The overall aim was to build a picture of companies' product development behaviours and identify the key information resources that contributed to the overall knowledge creation activities of the companies.

- Chapter 6, Organisational Innovativeness: Characteristics Distinguishing Innovative Companies, explores the key characteristics that differentiated the highly innovative companies in this study, both the organisational knowledge base and knowledge creation activities are explored.
- Chapter 7, The Knowledge Creating Company: Conclusions, draws together the key conclusions of the thesis and identifies areas for future investigation.

4. THE ORGANISATIONAL KNOWLEDGE BASE

4.1 INTRODUCTION

This chapter explores a series of attributes and measures surrounding the knowledge base of the companies that participated in the study. The chapter is split into four parts. The first provides an overview of organisational management and production practices, the second explores the range of information technology resources, the third investigates the information and knowledge resources within the companies, and the final section presents a summary of the knowledge bases that exist within the companies.

4.2 ORGANISATIONAL MANAGEMENT AND PRODUCTION SYSTEMS

A company's management systems and practices provide an insight into that organisation's codified knowledge base and its ability to manage and apply that knowledge base for business growth. This section provides an overview of the organisational management systems and practices of the companies that participated in the study.

4.2.1 Future Focus and Business Planning

Respondents were asked a series of questions surrounding their company's future focus and business planning activities. In terms of future direction, 81% (27) of the respondents saw their companies either growing or shifting their orientation in the future. The key dimensions identified for future growth were the expansion of markets, improved levels of exporting and the improvement of production processes. A total of 19% (6) of respondents saw their companies remaining in the status quo situation.

Two-thirds (22) of the companies had a written business plan, perhaps more significant was the fact the remaining one-third (11) did not. Of the eleven companies that did not have a business plan, one saw it as important but had not yet developed a plan, and two of the companies were currently in the process of developing a plan. Of the 22 companies that had business plans, 59% (13) identified future planning as the key benefit, and 18% (4) saw a business plan as critical to obtaining finance or investment.

Table 4-1 shows a cross-tabulation of the companies' future direction with their business planning activities. It is interesting to note that while 81% (27) of the companies were planning to undergo significant change or growth, only 67% (22) had a business plan.

Table 4-1: Future Directions and Business Planning

Future direction	Have formal business plan	No formal business plan	Total % (No.)
Growth/Refocus	20	7	81% (27)
Status quo	2	4	19% (6)
Total	**67% (22)**	**33% (11)**	**100% (33)**

Table 4-2 provides an overview of the companies' future expectations over a range of measures for their relative positions in five years. Overall the companies saw themselves substantially increasing their total sales, and their export sales. This will be achieved with moderate increases in both product range and staffing levels, and will require an increase by one-half of the current asset-base. The companies expect their profit levels to have nearly doubled during this period.

Table 4-2: Expected Positions of the Companies

Expected position in 5 years	Total sales	Export sales	Product range	Employment	Total assets	Net profit
Total growth over the next five years	119%	127%	22%	40%	54%	86%

4.2.2 Quality Management Systems

Two-thirds (22) of the companies had a formal quality management programme in place. Reasons given for having a formal quality management system in place included "satisfying customer demand", "being essential to the business", "being necessary for sub-contracting", and "providing a marketing edge". The descriptions of the types of quality management programmes used by the companies are shown in Table 4-3. The majority of the 22 companies that had a quality management system in place used the ISO 9002 standard. There were however a significant number, 27%, which used the more comprehensive ISO 9001 quality management standard.

Table 4-3: Quality Management Programmes

Description of quality management programme	% (No.)
ISO 9002	37% (12)
ISO 9001	27% (9)
Other	3% (1)
None	33% (11)
Total	**100% (33)**

There was a range of benefits identified by the 22 respondents that had a quality management system in place. The greatest perceived benefit was in the area of improved management systems and procedures with 64% (14) of the companies indicating this as a direct benefit. Significant benefits were also perceived in the areas of cost reductions and efficiency gains, 36% (8), and improved customer satisfaction and credibility, 32% (7). Two respondents reported that their companies had gained no significant benefit from the introduction of a quality management programme. In both these cases, the adoption of the quality management systems was driven by customer requirements.

Of the 11 companies that did not have a formal quality management programme in place, four were working towards implementing one. One respondent reported that their company was too small for formal quality management to be necessary as the company had less than 10 employees.

4.2.3 Technology and Production Processes

The respondents were asked to rate the extent to which the company had changed its basic technology and production processes, in the last year, and in the last five years. In terms of changes in the technology and production processes used the companies were clearly separated into two groups, those which actively invested in technology and production systems and those which did not. Table 4-4 shows the results.

Table 4-4: Change in Technology and Production Processes

Amount of change?	In the last year	In the last five years
1. Not at all	21% (7)	6% (2)
2. A little	48% (16)	55% (18)
3. Substantially	30% (10)	36% (12)
4. Completely	-	3% (1)
Total	**100% (33)**	**100% (33)**
Average score	**2.1**	**2.4**

In the last year, 70% (23) of the companies had not changed their technology or production processes at all or had updated them only a little. The remaining 30% (10) of companies had substantially changed their technology or production processes in the last year. In the last five years a total of 60% (20) of the companies had not changed their technology or production processes at all or had updated them only a little. This group included two companies that had not updated at all during this period. During the same period, the remaining 40% (13) of companies had either substantially updated their technology or production processes. In the last five years the technology and production processes used by the companies had changed only a little.

4.2.4 Management, Marketing and Support Systems

In the last year 42% (14) of the companies had either substantially or completely changed their management systems. In the last five years 67% (22) of the companies had either substantially or completely changed their management systems. During this five year period the remaining 33% (11) of the companies' management systems had either not changed at all (4 companies), or had changed a little (7 companies). The results are presented in Table 4-5.

Table 4-5: Change in Management, Marketing and Support Systems

Amount of change?	In the last year	In the last five years
1. Not at all	18% (6)	12% (4)
2. A little	39% (13)	21% (7)
3. Substantially	33% (11)	36% (12)
4. Completely	9% (3)	30% (10)
Total	**100% (33)**	**100% (33)**
Average score	**2.3**	**2.8**

The extent of change to management, marketing and support systems over the last five years was noticeably greater than that made to the technology and production systems. This is likely to reflect the increased costs of updating technology and production systems as compared to lesser cost and difficulty usually associated with updating the management, marketing or support systems within a company.

4.2.5 Technology Benchmarking

The respondents were asked to rate their company's plant equipment in relation to the best available. Table 4-6 shows the results. The companies were evenly split between those with plant and equipment that was four years old or less, and those which had plant and equipment that was greater than five years old. There was also one company that did not have any plant and equipment. This company contracted out the manufacturing aspects of the business. The average age of the current plant and equipment for the companies that participated in the study was just over five years behind the best available.

Table 4-6: Technology Benchmarking

How does the current plant/equipment compare with the best available?	% (No.)
1. > 10 years behind	18% (6)
2. 5 - 10 years behind	30% (10)
3. 2 - 4 years behind	42% (14)
4. Fully up to date	6% (2)
No plant	3% (1)
Total	**100% (33)**
Average score	**2.3**

4.2.6 Company Information Management Systems

The majority of respondents, 70% (23), indicated that their company had a formal information management system in place. Of these 23 companies 57% (13) indicated that they captured and used business-related information, 39% (8) captured and used product-related information and three of the companies had an in-house library. The remaining 30% (10) of the companies had no formal information management system in place. Of these 10 companies, three collected business-related information, two collected product-related information and one had an in-house library.

In the majority of companies, 82% (27), information management activities were the responsibility of an individual in a senior management position. In the remaining 18% (6) of the companies it was seen as a clerical activity. The respondents were asked to rate their level of satisfaction with their company's current information management system on a scale of 1 - 5, 1 being not at all satisfied, and 5 being extremely satisfied. The overall average rating was 2.9, i.e. on average companies were moderately satisfied with their current information management systems.

Table 4-7: Satisfaction with Current Information Management Systems

Use a formal system	Level of satisfaction					
	Not satisfied (1)	Slightly satisfied (2)	Moderately satisfied (3)	Very satisfied (4)	Total % (No.)	Average
Yes	1	2	14	6	70% (23)	3.1
No	1	2	7	0	30% (10)	2.6
Total	**2**	**4**	**21**	**6**	**100% (33)**	**2.9**

Table 4-7 shows the companies separated by use/non-use of a formal information management system. Those companies that had a formal system in place had an average satisfaction level of 3.1, just above moderately satisfied. Those companies with no formal system in place had an average of 2.6, falling between slightly and moderately satisfied. This difference is noticeably different; indicating that the companies who had formal information management systems in place were more satisfied with their current organisational information management systems.

4.3 INFORMATION TECHNOLOGY RESOURCES

Much has been written over the last few years on the ability of information technology to provide competitive advantage to an organisation. King and Grover (1991) stated that information technology can only be used to more effectively communicate and present information, and it is in fact the information that provides the competitive advantage. This section provides an overview of the information technology systems and practices of the companies that participated in the study. All 33 of the companies that took part in this study used computers in some capacity.

4.3.1 Application of Information Technology Resources

In terms of utilisation, 100% (33) of the companies made use of their information technology resources for accounting and administration activities, 45% (15) used them to aid in the design or production activities, 42% (14) used them for the purpose of inventory management, and 12% (4) of the companies for some form of communication.

4.3.2 Investment in Information Technology Resources

Table 4-8 shows the relative investments that the companies had made in information technology resources. The majority of the companies, 64% (21), had less than $50,000 invested in their information technology resources. These organisations generally had less than 50 employees. Just 12% (4) of the companies had information technology resources valued at between $50,000 and $500,000, with all these companies having greater than 10 employees. Each of the remaining 24% (8) of companies had information technology resources valued at over $500,000, and had more than 50 employees. Overall there was a clear relationship between company size and the level of investment in information technology. The larger the company, the greater the level of investment in information technology was likely to be.

Table 4-8: Investment in Information Technology Resources

	No. of Employees			Total
Investment in IT resources	**0 – 10**	**11- 50**	**50 +**	**% (No.)**
Less than $50,000	5	14	2	64% (21)
50,000 - $500,000	0	1	3	12% (4)
Greater than $500,000	0	0	8	24% (8)
Total	**5**	**15**	**13**	**100% (33)**

4.3.3 Impacts of Organisational Information Technology Resources

Respondents were asked to identify the benefits their organisation had gained through its investment in information technology resources. The results are shown in Table 4-9. Overall the identified benefits related to a greater ability to access and manage information. One respondent indicated that their company had gained no benefit from the information technology resources. This company had less than 10 employees.

Table 4-9: Benefits of Information Technology Resources

Benefits gained	% (No.)
Essential to business	18% (6)
More effective management	24% (8)
Efficiency gains	30% (10)
Access to timely information	33% (11)
Productivity gains	6% (2)
None	3% (1)

Following on from this question, respondents were asked a series of questions surrounding the impacts of their organisational information technology resources. The results are presented in Table 4-10.

Table 4-10: Impacts of Organisational Information Technology Resources

Benefits gained from information technology resources	Agree	Undecided	Disagree
Well worth the investment	85%	12%	3%
Significantly improved organisational effectiveness	85%	12%	3%
Improved quality of decision making	79%	12%	9%
Significantly improved customer service	70%	18%	12%
Helped in the provision of new products and services	52%	12%	36%
Helped to increase sales	39%	21%	40%
Problems resulting from information technology resources	**Agree**	**Undecided**	**Disagree**
Failed to meet some organisational requirements	52%	15%	33%
Have created problems within the organisation	34%	22%	44%
Fewer than expected benefits	12%	21%	67%
Systems have been a failure	6%	-	94%

Overall, 85% (28) of the respondents believed their information technology resources were well worth the investment. The same number believed that their information technology resources had improved the overall effectiveness of the organisation. When asked if the information technology resources had improved the quality of decision making 79% (26) of respondents agreed; 70% (23) agreed that information technology resources had improved customer service. Just over half, 52% (17), of the respondents believed that their organisation's information technology resources had helped in the provision of new products and services. Only 39% (13) of the respondents believed that their organisation's information technology resources had helped to increase sales.

When asked if their investment in information technology resources had been a failure, 94% (31) of the respondents disagreed, only 6% (2) agreed. The majority of the respondents, 67% (22) disagreed that their company information technology resources had delivered fewer benefits that expected. Just over half, 52% (17), of the respondents agreed that their information technology resources had failed to meet some of their organisational needs. Only 34% (11) of respondents agreed that their information technology resources had created problems.

4.3.4 Understanding and Use of the Internet

The respondents were asked to rate their current understanding of the Internet. The majority, 70% (23) had either a limited or no understanding of the Internet. The remaining 30% (10) had a good understanding of the Internet. It should be noted that this information was gathered in 1995.

Only 21% (7) of the companies were currently using the Internet in some capacity within their organisation. Of the seven companies that were currently using the Internet, four were using it for e-mail or file transfer, two were using it for the delivery of on-line support, one was using it for information scanning purposes, and one was using it as a promotional tool. All seven of the companies planned to expand their use of the Internet in the future. Among the potential future uses were information scanning, communication, and marketing. Of the remaining 79% (26) companies not using the Internet, 84% (19) of them indicated they planned to make use of it in the future. The future uses indicated were similar to those identified by the companies already using the Internet in some capacity.

4.4 ORGANISATIONAL KNOWLEDGE CREATION RESOURCES

Organisational knowledge creation resources are those resources that contribute to the creation of new knowledge within an organisation. These resources, which are both tacit and codified in nature, exist both within and outside of the company. This section presents an overview of the extent of these resources in the companies that participated in the study.

4.4.1 Responsibility for Sourcing Information

The respondents were asked to identify who within their organisations was responsible for the sourcing of information. A total of 48% (16) of respondents identified senior management, 36% (12) identified everyone within the organisation, and the remaining 15% (5) identified other groups within the organisation, e.g. the marketing division. There was no single method that was used by all the companies that participated in this study.

4.4.2 Technical Qualifications

In over 60% of the companies, less than 20% of employees held a technical qualification. Table 4-11 shows these results.

Table 4-11: Proportion of Technically Qualified Employees

Technically qualified employees % of total employees	Total employees			Total
	0 - 10	11 – 50	50+	% (No.)
< 10%	0	3	4	21% (7)
10% - 20%	3	5	6	42% (14)
21% - 50%	1	7	2	30% (10)
> 51%	1	0	1	7% (2)
Total	**5**	**15**	**13**	**100% (33)**

Within this group, companies with greater than 50 employees were proportionally over represented. The opposite was true for the remaining 40% of the companies, where the proportion of technically qualified employees was greater than 20%; these companies were more likely to have between 11 and 50 employees. This seems to indicate that as companies grow larger the relative mix of required skills change.

4.4.3 Use of External Business Consultants

Business consultants were used by 82% (27) of the companies in the study. Of those 27 companies, 93% (25) made use of one or more business orientated consultant e.g., lawyer, accountant, human resource, marketing, advertising, or management consultant, while only 48% (13) of the 27 companies made use of consultants with technical expertise e.g., engineers or designers.

4.4.4 Sources of New Product Ideas

The respondents were asked to identify the main sources of new product ideas in their organisation. The majority of companies, 64% (21), got their product ideas from either an identified market need or from a customer. Less frequently used sources included company staff, magazines and overseas travel. The full set of sources is identified in Table 4-12. Overall the sources tended to be external to the company.

Table 4-12: Sources of New Product Ideas

Sources of new product Ideas	% of companies (No.)
Market need/Customers	64% (21)
Company staff	36% (12)
Mags/Literature	21% (7)
Overseas travel	21% (7)
Management	15% (5)
Conferences/Trade shows	15% (5)
Consultants/External sources	15% (5)
Competitors' products	15% (5)
New technology	9% (3)
Product improvements	9% (3)
Suppliers	9% (3)

4.4.5 Sources of Information for Business Activity

The respondents were presented with a range of information sources, both internal and external, and asked to specify how information from these sources was gathered, either formally or informally. They were also asked to rate the importance of each source to their company's overall business activity. These ratings were determined by asking respondents to score each information source on an importance scale. The scale went from 1, being not important, to 5, being vitally important to overall business activity. The results identified three distinct groupings of information sources: low, medium and high-level importance sources. The average importance score for each information source was used to identify these groupings. It should be noted that the respondents were not asked to comment on the importance of in-house sources in relation to overall business activity, this was an oversight by the author. In-house sources were defined as those codified sources that existed within the company. In-house sources were explored in relation to organisational product development activities. The results are presented in Table 4-13.

Table 4-13: Importance of Information Sources

Information sources	Importance rating	Tacit	Codified	Both/Formal	Informal only	Not relevant
Highly important information sources						
Customers	4.6	T	C	79% (26)	18% (6)	3% (1)
Personal experience	4.4	T	-	58% (19)	42% (18)	-
Company staff	3.9	T	-	58% (19)	39% (13)	3% (1)
Moderately important information sources						
Other companies	3.4	T	C	58% (19)	36% (12)	6% (2)
Suppliers	3.3	T	C	82% (27)	9% (3)	3% (1)
Exhibitions/Conferences	3.2	T	C	70% (21)	21% (7)	9% (3)
Trade journals	3.1	-	C	70% (21)	27% (9)	3% (1)
Professional bodies	2.8	T	C	70% (23)	12% (4)	18% (6)
Business consultants	2.7	T	C	70% (23)	15% (5)	15% (5)
Govt agencies	2.6	T	C	76% (25)	3% (1)	21% (7)
Patent information	2.6	-	C	70% (23)	9% (3)	21% (7)
Information sources of low importance						
Libraries	2.4	-	C	58% (19)	18% (6)	24% (8)
Media	2.3	-	C	39% (13)	36% (12)	24% (8)
Family & friends	2.3	T	C	21% (7)	55% (18)	24% (8)
On-line sources	2.2	-	C	39% (13)	21% (7)	39% (13)
Information brokers	2.0	-	C	36% (12)	9% (3)	55% (18)

Highly Important Information

Three sources of information were identified as highly important to overall business activity: customers, personal experience and company staff. These sources were predominantly tacit in nature, with a lesser codified element. Customer information was acquired through both formal and informal methods by 79% of the companies, while both personal experience and company staff information were acquired both formally and informally by 58% of companies. These lower levels of formal information collection were likely to result from the exclusively tacit nature of both personal experience and company staff. It is interesting to note that both these sources were each identified as not relevant by one respondent.

Moderately Important Information Sources

There were eight information sources that were classified as moderately important to overall business activity. These sources were communicated through a mix of tacit and codified transfer methods. The majority of companies made use of both formal and informal methods of collection for all of these sources. Just over 20% of companies regarded information from government agencies and patents as not relevant, while 18% found no value in information from professional bodies and 15% made no use of business consultants.

Information Sources of Low Importance

Five sources of information were classified as being of low importance to overall business activity: libraries, media, family and friends, on-line sources and information brokers. Information from these sources was almost exclusively codified in nature. The levels of both formal and informal information-gathering from these sources were relatively low. Informal information acquisition was generally higher from these sources. These five sources were also seen as being less relevant to overall business activity as indicated by the number of companies that did not use them at all.

4.4.6 Company Asset Rankings

The respondents were asked to rank a selection of company assets in order of importance from 1 - 6, 1 being the most valuable asset to the overall success of the business and 6 being the least. The average asset ranking and their respective standard deviations are presented in Table 4-14.

Table 4-14: Company Asset Ranking

Company asset	Average ranking	Standard deviation
Staff	1.6	0.7
Customers	1.7	0.9
Plant/Machinery	3.4	1.6
Business information	3.7	1.6
Raw materials	4.0	1.7
Information technology resources	4.4	1.7

The key assets for business success were clearly the staff and the customers. The standard deviation for staff and customers was smaller than any of the other assets, indicating there was a greater level of consensus amongst the companies as to the greater overall importance of these assets. The remaining assets received similar ratings, with only information technology resources receiving a slightly lower rating.

4.5 AN OVERVIEW OF THE ORGANISATIONAL KNOWLEDGE BASE

The vast majority of companies in this study saw themselves as either growing or shifting their business orientation in the future. However, only two-thirds of the companies had a business plan in place. The companies' management, marketing and support systems were more up-to-date than their technology and production systems. This was likely due to the higher costs and greater difficulty of updating technology or production systems. Table 4-15 shows a comparison of the current study with a study of New Zealand's innovation environment undertaken by Frater et al. (1995). There is a close alignment between the findings of the two studies. The greatest difference was in relation to the technology and production practices, with the companies in the Frater et al. study having slightly more up-to-date systems in this area.

Table 4-15: Comparison of Organisational Management, and Production Systems

Changes over the last five years	Current study	Frater et al. 1995
Changes in technology and production processes[1]	2.4	2.9
Changes in management, marketing and support systems[1]	2.8	3.1
Benchmark of plant and equipment with best available[2]	2.3	2.0

1. Scores, 1 (not at all) - 4 (completely)

2. Scores, 1 (more than 10 years behind) - 4 (fully up-to-date)

All 33 companies that participated in the study made use of information technology resources within their organisations. Improved organisational effectiveness, improved quality of decision making, and improved customer service were identified as the three most significant benefits of the information technology resources to the organisations. In 1992, Janczewski's study of the relationship between information technology and competitive advantage in New Zealand business identified improved efficiency and reduced staffing levels as the key benefits to result from information technology resources. In a more recent study LeBlanc (1997) identified improved efficiency as the principal reason for introducing computers into the organisation. Just over half of the respondents in the current study indicated that their information technology resources had made a positive contribution to the provision of a new product or service. This result is consistent with the findings of Cragg (1991) who suggested that rather than focusing on gaining competitive advantage from information technology resources, companies should focus on gaining competitive advantage through the intelligent application of information and knowledge. **While information technology resources have improved the operational effectiveness of the companies, they are still not making a significant impact on knowledge creation activities.**

On average the companies had 20% of employees who held a technically based qualification. This compares to a figure of 19% reported by Kerr (1995) in his study of product development practices of New Zealand manufacturing companies. Smaller companies (less than 50 people) were more likely to have a greater proportion than this.

The most popular information sources for new product ideas were customer needs and company staff. These findings are supported by previous research where customers were found to be one of the most important sources of new product ideas (Cooper and Kleinschmidt, 1986; Kerr 1995; Pavia, 1991; and Sanchez and Elola, 1991). In addition, Kerr's research also identified company staff as an important source of new product ideas.

Overall there appears to be a fairly narrow base from which new ideas are generated in relation to product development activities in both the current and previous studies.

The companies identified tacit-orientated information sources as being key to their overall business activity. Customers, along with personal experience and company staff, were rated as the three most important information sources. As the information sources decreased in reported importance they became more codified in nature. The majority of companies adopted a fairly informal approach to the acquisition of information. Gnomes (1998), in her study of New Zealand small and medium sized companies information acquisition behaviours identified customers, management, suppliers and periodicals as the key organisational information sources. The appearance of periodical information as a key information resource is at odds with the current study's results, where periodical information (in the form of trade-related journals) was only classified as a moderately important source. Chalmers (1994) reported that information gained first hand from personal contacts, such as that from agents, company staff, competitors, trade sources, distributors and suppliers, was more highly valued than published information. When published information was used it was generally sourced from trade, industry or professional journals. Johnston's (1991) study of technology strategy development in New Zealand industry identified customers and suppliers as key resources. **Both the current and previous studies identified customers, company staff and personal experience as being the critical information sources to overall business activity**.

Another point of interest is the high degree of informal information acquisition behaviour amongst the companies. This type of acquisition behaviour reflects a reactive approach to the gathering of information to address immediate problems, as opposed to a more formal acquisition process where information is strategically gathered. This result is again consistent with previous research results: Chalmers (1994), Gnomes (1998), Roberts and Clifford (1986), Sharkey (1992).

The reliance on highly tacit information might also explain the relatively low level of corporate satisfaction with their information management systems. These systems only have the capacity to manage codified information, which was shown to be of lesser importance to the companies' overall business activities.

It is clear that tacit knowledge is valued more highly than the codified knowledge base that exists within the companies. However at the present time there are not the systems in place to adequately capture and manage this tacit knowledge base.

5. ORGANISATIONAL KNOWLEDGE CREATION

5.1 INTRODUCTION

This chapter explores the attitudes of respondents to product development and the importance of product development activities in their companies. It also investigates the relative importance and use of various information sources in relation to product development activities. A picture of companies' product development practices, which identifies the key information resources that contribute to knowledge creation activities, is developed.

5.2 IMPORTANCE AND USE OF PRODUCT DEVELOPMENT

5.2.1 Importance of Product Development to the Organisation

Respondents were asked to rate the importance of product development to their overall success. Figure 5-1 shows the results. A total of 82% (27) of the companies identified product development as either very or vitally important to their organisational success, 15% (5) rated it as moderately important and only one company rated it as slightly important.

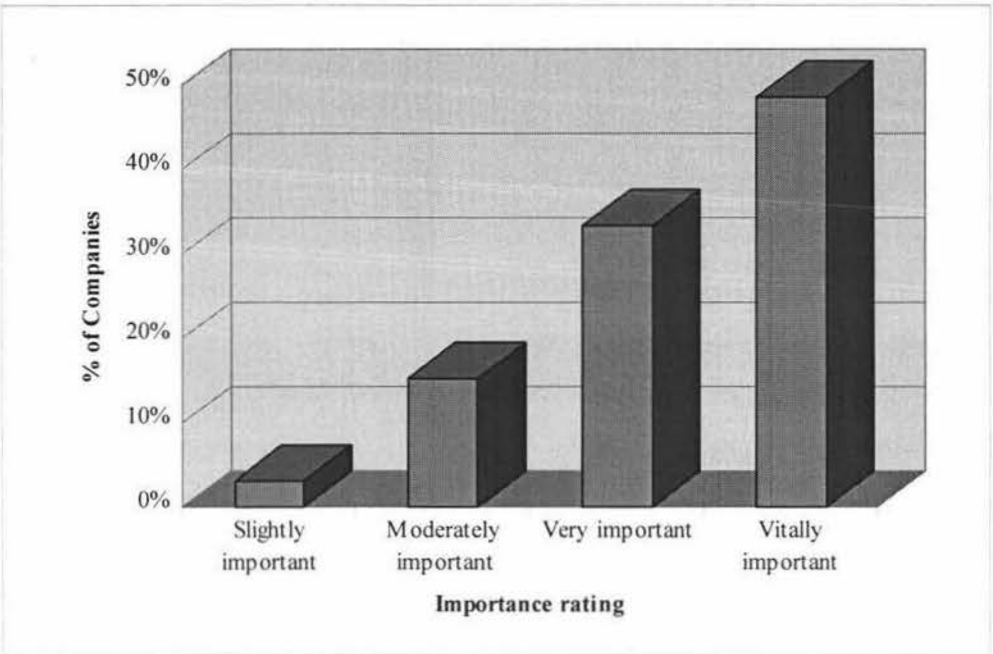

Figure 5-1: Importance of Product Development to Overall Success

5.2.2 Formality of the Product Development Process

Just over half, 52% (17), of the companies used a formal product development process, the remaining 48% (16) did not use a formal process. There were a number of reasons given for the use of a formal process including: "quality systems requiring a process"; "provides consistency and reliability"; and "the provision of a formal framework". Reasons given for not using a formal process included: "a process is only needed for product testing", and "only internal ideas are being used".

5.2.3 Relative Importance and Use of Product Development Activities

Respondents were asked to rate the relative importance of 14 product development activities. Respondents scored each product development activity on an importance scale. The scale ranged from 1, being not important, to 5, being vitally important to overall business activity. Respondents were also asked to identify which activities they made use of in their company's product development programme.

Table 5-1: Importance and Use of Product Development Activities

Product Development Activity	Average Importance Score	Companies Using Activity
Highly Important		
Detailed design	4.2	88%
Prototype design	4.1	88%
Moderately Important		
Production start-up	3.8	85%
Preliminary market assessment	3.8	82%
Preliminary technical assessment	3.7	85%
Financial feasibility study	3.7	76%
Consumer testing	3.6	70%
In-house testing	3.5	79%
Trial production	3.5	70%
Market launch	3.5	70%
Initial screening	3.4	76%
Low Importance		
Test market	3.2	58%
Detailed market research	2.8	55%
Pre-launch business analysis	2.8	45%

Respondents identified only two activities as being highly important to their overall product development programme, detailed design and prototype design, with these being used by 88% of the companies. The majority of activities were classified as being moderately important; these activities were used by between 85% and 76% of the companies. Only three of the activities were rated as being of low importance, test marketing, detailed market research and pre-launch business analysis; these activities were used by 58%, 55% and 45% of the companies respectively.

There was a strong relationship between the importance rating of the individual activities and the number of companies that were performing that activity. The most important and most used activities were related to the physical design and manufacture of the product, and on assessing the viability of the product concept in the early stages. The activities that were least used all focussed on intangible elements within the product development process – test marketing of a product, detailed market research and pre-launch business analysis.

The companies on average completed 10.6 activities out of the possible set of 14. Just over half the companies, 51% (17), used 12 or more of the product development activities. The remaining companies used between 2 and 11 product development process activities as part of their product development process.

5.2.4 Problems and Barriers that Inhibit Product Development

Respondents were asked to identify the significant barriers and problems inhibiting their company's product development activities. Table 5-2 identifies two major areas. A lack of resources was identified as the main barrier to product development activities for the companies, with 94% of respondents identifying this as a barrier. In relation to specific resourcing areas, 39% identified financial constraints, 36% identified human resource constraints, and 27% identified time availability constraints. In a number of instances the respondents identified more than one resource constraint. The other area identified was a lack of information or ideas, with 15% of companies indicating this was a barrier to product development.

Table 5-2: Problems and Barriers to Product Development

Problem/Barrier	% (No.)
Resource constraints*	94% (31)
Including:	
- Financial constraints*	39% (13)
- People*	36% (12)
- Time*	27% (9)
Lack of ideas/Information	15% (5)

*Note that the resource figures are not cumulative

5.2.5 Factors Needed to Encourage Product Development

Three factors were identified as being necessary to encourage good product development practices within the company. Just over 60% of respondents identified strong leadership and clear direction from the management team as being important. A positive enterprise culture that encouraged and rewarded innovation, while at the same time tolerating failure, was identified by 49% of the respondents. The final issue raised by respondents was the need for adequate resources, financial, physical and intellectual, to support product development activities.

5.3 INFORMATION RESOURCES FOR PRODUCT DEVELOPMENT

5.3.1 Importance of Information Resources to Product Development Activities

Respondents were asked to value the overall importance of their company's information resources in relation to the success of their product development activities on a scale from 1 (no value at all) to 5 (extremely valuable). The majority of the respondents, 76% (25), indicated that their company information resources were either very or extremely valuable to the success of their overall product development activities (Figure 5-2).

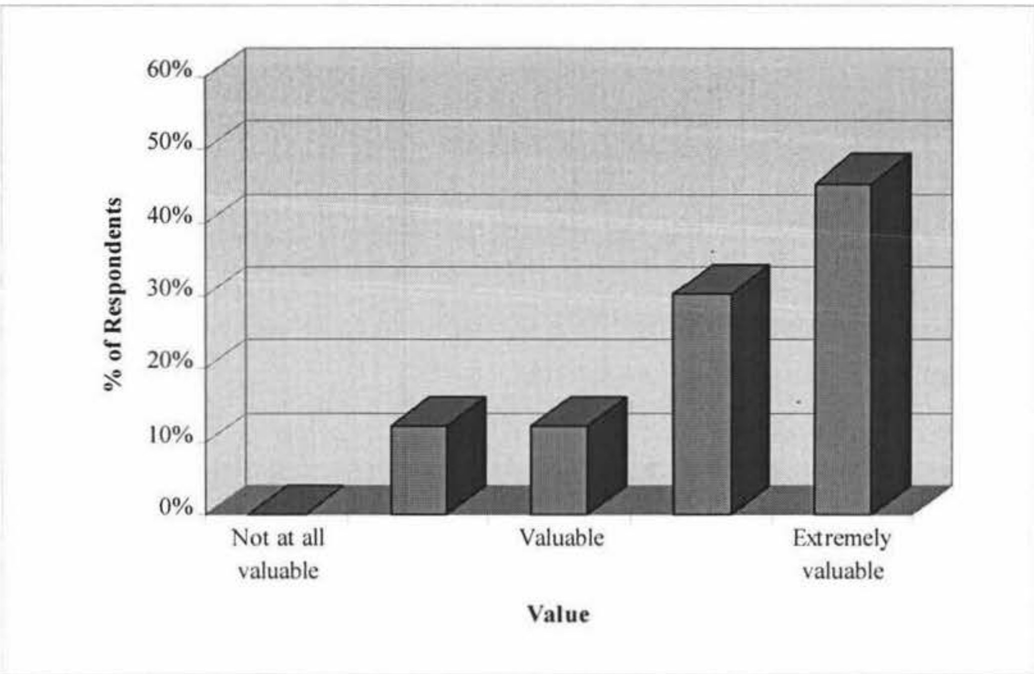

Figure 5-2: Value of Company Information Resources to Product Development Activities

5.3.2 Use of Information Sources

Respondents were asked to indicate the frequency with which they used their various information sources in relation to their overall product development activities on a scale between 1 (not at all) and 5 (all the time). Three groups of information resources were identified: heavily used sources (a rating of 3.5 or greater); moderately used sources (a rating between 3.5 and 2); and those sources with low levels of usage (a rating of less than 2). These are outlined in Table 5-3.

Table 5-3: Frequency of Use of Information Sources in Product Development

Information source	Frequency of use for product development	Overall importance to business	Information type	
Heavily used sources	**(Rating out of 5)**	**(Rating out of 5)**	**Tacit**	**Codified**
Personal experience	4.4	4.4	T	-
Customers	4.0	4.6	T	C
Company staff	3.6	3.9	T	-
In-house sources	3.6	*	-	C
Moderately used sources				
Exhibitions/Conferences	2.9	3.2	T	C
Other companies	2.9	3.4	T	C
Suppliers	2.9	3.3	T	C
Trade journals	2.8	3.1	-	C
Infrequently Used Sources				
Professional bodies	2.4	2.8	T	C
Business consultants	2.4	2.7	T	C
Patent information	2.2	2.6	-	C
Family & friends	2.2	2.3	T	C
Media	2.1	2.3	-	C
Libraries	2.1	2.4	-	C
Govt agencies	1.9	2.6	T	C
On-line sources	1.7	2.2	-	C
Information brokers	1.6	2.0	-	C

** Due to an error in the drafting of the survey questions, respondents were not asked to rate the importance of information sources to general business activity.*

The four information sources that were being heavily used in relation to product development activities were a mix of tacit and codified sources. Three out of the four heavily used sources were internal (personal experience, company staff and other in-house sources). Customers were the only significant external source of product development information.

The four information sources used to a moderate level in relation to product development activities were communicated by a mix of tacit and codified knowledge transfer. Each of the sources was external to the company. All nine infrequently used information sources were external to the company. These sources were predominantly codified in nature, but also included a lesser tacit component.

When the usage levels of information sources for product development activities were compared to the importance levels of those same information sources to the companies' overall business activities an extremely close correlation was found, 0.98. The key difference between these two sets of data was that the average importance to overall business activity of the information sources was 0.4 above that same source's usage level in relation to product development activities. This indicates that organisational information sources were slightly less important to the activity of product development than they were to overall business activity.

5.4 INFORMATION SOURCES FOR PRODUCT DEVELOPMENT ACTIVITIES

Respondents were asked to identify the key information sources used in each of the 14 product development activities. For the purposes of this analysis the 14 product development activities have been divided into three groups: pre-development analysis; product design and testing; and product commercialisation. Only those information sources that were used by over 30% of the respondents are presented. The information sources are ranked from the most used to the least used by taking the average over all the activities in each of the three groups.

5.4.1 Pre-development Analysis Activities

Pre-development analysis activities focus on the screening of ideas and the evaluation of the overall feasibility of the proposed product concept. The following activities are included: initial screening (I.S.); preliminary market analysis (P.M.A.); preliminary technical analysis (P.T.A.); detailed market research (D.M.R.); and a financial feasibility study (F.F.S.).

Table 5-4: Use of Information Sources in Pre-Development Analysis

Information sources	I.S.	P.M.A	P.T.A.	D.M.R.	F.F.S.	Overall average	Tacit	Codified
Personal experience	85%	61%	64%	39%	70%	64%	T	-
Customers	79%	88%	30%	70%	-	57%	T	C
Company staff	61%	42%	52%	-	42%	44%	T	-
In-house sources	48%	36%	55%	-	52%	43%	-	C
Other companies	42%	39%	-	30%	-	30%	T	C
Suppliers	33%	-	42%	30%	-	28%	T	C
Business consultants	-	-	-	36%	-	19%	T	C

Two information sources, personal experience and customers, were used most often by the companies in the pre-development phase. There was a surprisingly low usage of information sources overall – only personal experience for initial screening, and customers for preliminary market analysis were used by over 80% of the companies, and only customers in initial screening and detailed market research, and personal experience in financial feasibility were used by over 70% of the companies. There was a high level of tacit orientated knowledge transfer required to communicate both personal experience and customer information, with only customers incorporating a codified knowledge element.

5.4.2 Product Design and Testing Activities

The product design and testing activities focus on the design, technical testing and market testing of the product. The following activities were included, prototype design (P.D.), in-house testing (I.H.T.), consumer testing (C.T.), detailed design (D.D.), trial production (T.P.) and test marketing (T.M.).

Table 5-5: Use of Information Sources in Product Design and Testing

Information sources	P.D.	I.H.T.	C.T.	D.D.	T.P.	T.M.	Overall average	Tacit	Codified
Personal experience	82%	67%	36%	73%	48%	36%	57%	T	-
Company staff	55%	67%	42%	67%	73%	39%	57%	T	-
Customers	42%	24%	67%	33%	30%	82%	46%	T	C
In-house sources	48%	42%	-	52%	48%	-	38%	-	C
Suppliers	30%	-	-	30%	30%	-	24%	T	C

Again the use of information sources for the activities in the product design and testing phase was relatively low. Only personal experience in prototype design and detailed design, company staff in trial production, and customers in test marketing were used by over 70% of the companies. These sources were all highly tacit in nature, with only customer information incorporating a codified element.

5.4.3 Product Commercialisation Activities

The product commercialisation activities focus on the final pre-launch business analysis (P.B.A.), production start-up activities (P.S.U.) and market launch (M.L.) of the product.

Table 5-6: Use of Information Sources for Product Commercialisation

Information sources	P.B.A.	P.S.U.	M.L.	Overall average	Tacit	Codified
Company staff	33%	73%	39%	48%	T	-
Personal experience	48%	48%	36%	44%	T	-
Customers	36%	-	70%	42%	T	C
In-house sources	30%	45%	-	32%	-	C
Exhibition/Conference	-	-	39%	17%	T	C

The use of information in the product commercialisation phases was the lowest of the three groups of activities. Only company staff in production start-up and customers in market launch were used by over 70% of the companies.

5.5 AN OVERVIEW OF ORGANISATIONAL KNOWLEDGE CREATION

The vast majority of respondents regarded product development as either very or vitally important to the overall success of their company. Just over half of the companies made use of a formal product development process. This is consistent with recent studies of companies in the U.S., where 60% and 56% respectively reported using a formal product development process (Griffin, 1997 and Page, 1993).

This study used a product development process model based on Cooper and Kleinschmidt's 1986 model. A number of previous studies have explored organisational product development activities based on the Cooper and Kleinschmidt (1986) model. These include Kerr (1995) who investigated product development practices in a group of New Zealand manufacturing companies, and Sanchez and Elola (1991) who conducted a study looking at the product development practices of a group of Spanish companies. Cooper and Kleinschmidt's original study was based on research undertaken with Canadian companies. Figure 5-3 shows a comparison between the frequency of product development activity use reported in each of these studies.

Across all the studies the most common activities related to the physical design and manufacture of the product, and assessment of the viability of the product in the early stages of development. The activities that were least used were notable in that they all focussed on intangible elements within the product development process: test marketing, detailed market research and pre-launch business analysis. It is interesting to note that the activities of trial production and production start-up were performed more frequently in both the New Zealand studies. This is possibly due to the generally smaller size of the New Zealand companies. This smaller size means that these companies will likely have more flexible production systems that are better able to be utilised for trial productions as part of their product development activities.

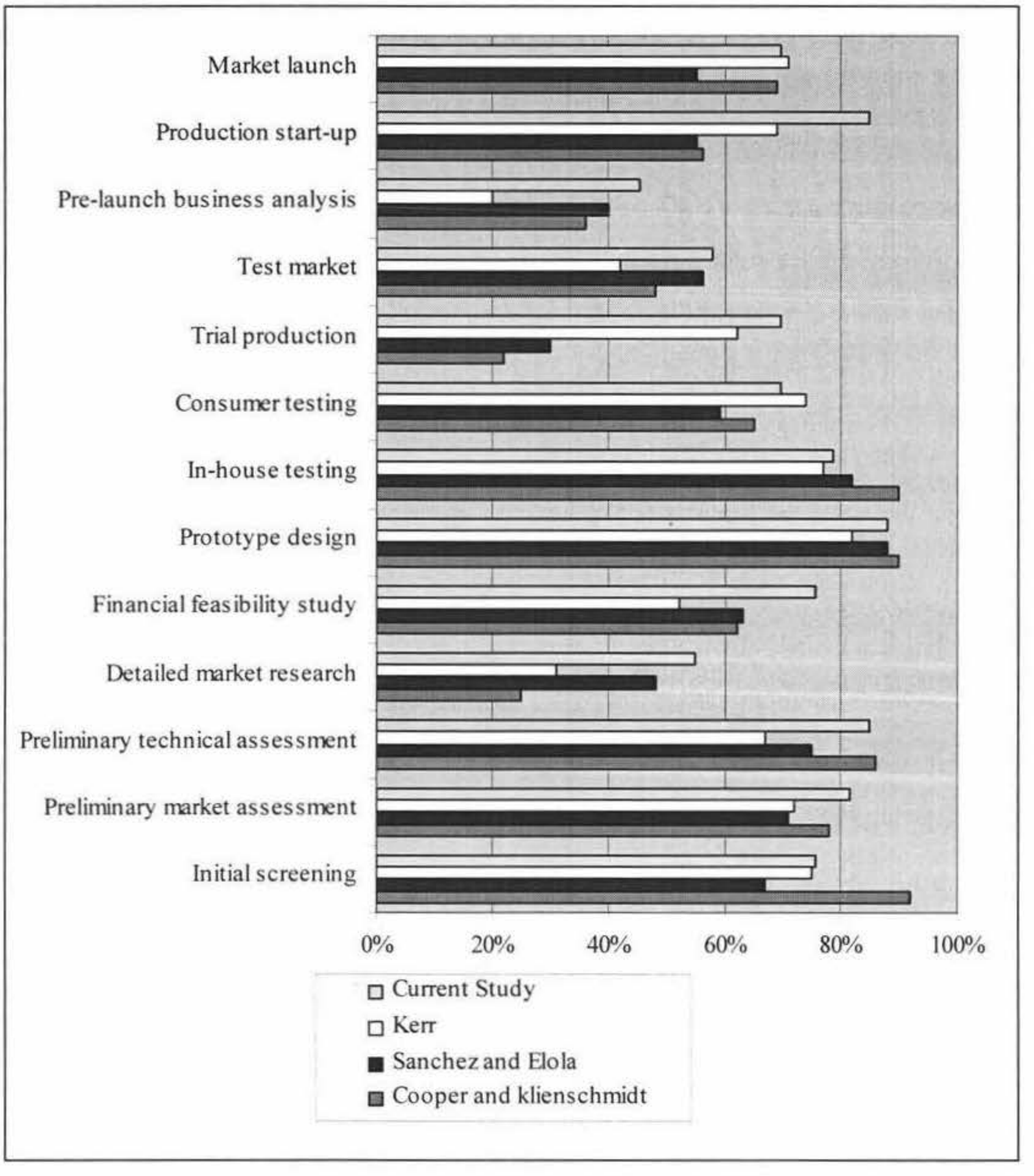

Figure 5-3: Comparison of the Use of Product Development Activities

The companies on average completed 10.6 activities out of the possible set of 14. Just over half the companies completed 12 or more of the product development activities, the remaining companies used between 2 and 11 activities within the product development process. It should be noted that the detailed design activity was added to Cooper and Kleinschmidt's original model in order to explore the information sources that were drawn on during the performance of this activity. When that activity is removed from the set, the average number of activities used is 9.7. This compares to averages of between 8 and 9 reported by Cooper and Kleinschmidt (1986), Kerr (1995), Mahajan and Wind (1992) and Sanchez and Elola (1991). The companies in the current study appear to be performing on average one more activity than has previously been reported. This indicates an increased appreciation that the use of formal processes can result in more successful product development outcomes.

A lack of resources; financial, people and time-based, was identified as the most significant barrier to product development within the companies. This finding mirrors the findings of recent U.S. research which identified resource constraints as the most frequently reported barrier to successful product development (Page, 1993). In a recent study comparing U.S. and Japanese innovation management activities, 43% of the U.S. companies identified a shortage of financial resources as their greatest barrier to product development. By contrast, the Japanese companies identified a difficulty in hiring qualified engineers as their greatest barrier (LeBlanc, 1997). The resource barriers that exist in New Zealand appear to be a combination of both of these elements, with both financial and people-based resource constraints being reported in the current study.

The majority of the companies rated their information resources as either very or vitally important to the overall success of their product development activity. There was a strong emphasis on both internal information sources and on external sources that were highly focused on industry or production-specific issues. There was also a strong association between the information sources that the respondents identified as being important to overall business activity and the sources that the companies reported using most frequently in their product development activities.

The heavily used information sources in relation to product development included personal experience, customers, company staff and in-house sources. Overall these sources were highly internally focused, with the exception of the customer-based information. These sources also incorporated a large element of tacit-based knowledge. The moderately used sources all existed outside of the companies, but focused on information that was industry specific. These sources required a mix of tacit and codified knowledge transfer. The least used sources, which were highly codified in nature and covered a broad range of information sources, all existed outside the organisation and were generally non-industry specific.

Frater et al. (1995) in their study of New Zealand's innovation environment identified a similar set of information sources to those identified in the current study. The most important information sources identified by Frater et al. were individuals, either within the company or customer based information. The moderately important information sources Frater et al. identified covered a wider scope, but still closely aligned to the set of information sources that the current study identified. In an earlier study Von Hippel (1988) identified suppliers and customers as the most relevant sources of information for driving innovative activity.

All these studies identified the importance of informal, tacit-orientated information sources to product development activities.\

The companies surveyed utilised a relatively narrow base of information in relation to their product development activities, generally relying on sources that were internal to the company, or sources that were readily accessible, such as customers. This finding is supported by Gnomes (1998) who suggested that at present companies are only utilising a narrow range of the possible information resources available. This narrow information base may be limiting the range of projects that are being undertaken by the companies. A greater focus on external sources could provide a greater range of opportunities to the companies in terms of their overall knowledge creation activities.

6. ORGANISATIONAL INNOVATIVENESS: CHARACTERISTICS DISTINGUISHING INNOVATIVE COMPANIES

6.1 INTRODUCTION

Innovation has been described as "a continuous process of learning, searching and exploring which results in new products, new processes, new organisations and new markets" (Freeman, 1988). Nonaka and Takeuchi, (1995), stated that innovation is facilitated by a process of organisational knowledge creation. They went on to state that the process of new product development is a core process for creating new knowledge. How well companies manage their product development processes and activities becomes a critical determinant of how successful organisational knowledge creation is carried out, and in turn the levels of innovation that are achieved.

This chapter explores the key characteristics that differentiate the highly innovative companies in this study; both the organisational knowledge base and knowledge creation activities are explored.

6.2 PROFILE OF COMPANY INNOVATIVENESS

A factor analysis based on eight questions in the study was used to construct an "innovation index". The purpose of this index was to rank the 33 companies in terms of their innovativeness in relation to their knowledge creation activities. The 33 companies were split into three groups, with the highest third being termed the highly innovative, the middle third being termed the moderately innovative and the lower third being termed the least innovative. A profile of the 33 companies in relation to the eight variables is outlined in Table 6.1. The figures given in the parentheses are drawn from Frater et al.'s (1995) earlier study. Frater et al. identified the highly innovative companies as those in the top quartile, while those in the bottom quartile were labelled the least innovative group of companies. The Frater et al. (1995) innovation index was constructed from a sample of 416 companies, a far larger sample than the 33 companies used in this study.

Table 6-1: Company Innovation Scores

Innovation index variable	All respondents	Highly innovative	Moderately innovative	Least innovative
Export growth – next 5 yrs..	127% *(181%)**	254% *(366%)*	100%	18% *(108%)*
No. of new products – last 5 yrs..	14.2 *(16.4)*	25.7 *(18.6)*	8.5	8.4 *(6.4)*
No. of improved products – last 5 yrs..	24.5 *(15.6)*	47.5 *(18.7)*	21.6	4.5 *(12.9)*
Proportion of sales from new products	27% *(30%)*	42% *(49%)*	19%	18% *(20%)*
Proportion of sales from improved products	24% *(28%)*	32% *(31%)*	25%	15% *(18%)*
Success of new products over last 5 yrs..[1]	4.0	4.0	4.6	3. 5
Change in production processes – last 5 yrs..[2]	2.4 *(2.9)*	2.6 *(3.3)*	2.5	1.9 *(2.5)*
Change in mgmt, mrkting and support systems - last 5 yrs..[2]	2.8 *(3.1)*	3.5 *(3.8)*	2.7	2.4 *(2.6)*
Comparative status of plant equipment with best technology[3]	2.3 *(2.0)*	2.9 *(2.0)*	2.9	2.1 *(1.9)*

Notes 1. Scores, 1 (most failed) - 5 (highly successful)

2. Scores, 1 (not at all) - 4 (completely)

3. Scores, 1 (more than 10 years behind) - 4 (fully up-to-date)

** Data from Frater et al. (1995).*

The highly innovative companies saw their export growth in the next five years as being noticeably greater that the two other groups. The difference between the highly innovative and the least innovative companies was a factor of 10. The number of new and improved products introduced over the last five years by the highly innovative companies was also far greater than the amount reported by both the moderately innovative and the least innovative companies during the same period.

In the last year the highly innovative companies generated a total of 74% of their current sales revenue from either new or significantly improved products, with over 40% of the sales revenue coming from new products alone. This compared with just 44% and 33% of sales revenue from either new or improved products respectively for the moderately innovative and least innovative companies. In a recent study of US companies product development practices Griffin (1997) reported rates of 49.4% and 25.5% respectively for the "best" and the "rest" in terms of percentage of sales revenue generated from new products. Page (1993) reported a figure of 32% of sales revenue from new products introduced in the previous five years.

In relation to overall success of products introduced in the last five years the moderately innovative companies claimed the highest degree of success, followed by the highly innovative and then the least innovative companies. While the moderately innovative companies claimed more success with the products that had been introduced, the absolute numbers of new products being introduced by this group was far less than the number of new products being introduced by the highly innovative companies.

The changes in production processes, management, marketing and support systems across the 33 companies were relatively similar over the last five years. However there was a trend for the more innovative companies to have production processes, management, marketing and support systems that were more up-to-date. When comparing the companies' plant and equipment to the best available the highly innovative and the moderately innovative companies received the same ratings; with the least innovative companies having less up-to-date plant and equipment.

Overall there appeared to be a wider gap between the highly innovative and the least innovative companies in this study, compared to the companies studied by Frater et al. (1995). The highly innovative companies in the sample were relatively similar to those identified by Frater et al., while there were far larger difference between the least innovative companies in this study and those identified by Frater et al. One possible explanation for this difference is the concentrated geographical location of the companies in this study. Only companies in the Wellington and Manawatu regions were surveyed, while the Frater et al. study covered the whole of the country.

6.3 CHARACTERISTICS OF THE COMPANIES

The highly innovative and moderately innovative companies, on average, had a greater number of employees, with 91% having staff numbers of greater than 10 people. Only 63% of the least innovative companies were greater than 10 people in size. There was no distinction between the samples in terms of company age. Table 6-2 shows the market focus of the three groups. The highly innovative companies were more likely to produce products that were aimed at a commercial or building orientated market, while the least innovative group were more likely to be focused on consumer orientated markets. When comparing these companies to the total sample, they were more likely to be involved in the commercial/building industries than either of the other two groups. The least innovative companies were notable in relation to their over-representation in the consumer products area.

Table 6-2: Market Focus of the Companies

Market focus	Highly innovative	Moderately innovative	Least innovative	Total (33 companies)
Consumer	18%	27%	55%	**33%**
Industrial	18%	36%	9%	**21%**
Commercial/Building	64%	36%	36%	**46%**

The net profits of 45% and 54% respectively of the highly and moderately innovative companies were above $500,000. Only 27% of the least innovative companies had profits above this level.

The vast majority of companies in all three groups, between 82% and 91%, were involved in exporting. Those companies classified as either highly or moderately innovative exported 24% and 32% respectively of their total production. The least innovative companies exported only 13% of their production. While all of the companies were currently involved in exporting there was a large difference in the expected export growth in the next five years as outlined in Table 6-3. The highly innovative companies saw their exports growing by 254%, the moderately innovative companies by 100% and the least innovative companies by only 18%. While the moderately innovative companies are currently exporting the greatest proportion of their production, their future growth expectations are far less optimistic than the highly innovative companies.

Table 6-3: Expectation of Organisational Position in Five Years

Future expectations	Highly innovative	Moderately innovative	Least innovative
Increase in exports	254% (181%)*	100%	18% (108%)
Increase in total sales	150% *(154%)*	165%	34% *(78%)*
Increase in product range	39% *(66%)*	21%	4% *(19%)*
Increase in employment	60% *(55%)*	51%	6% *(25%)*
Increase in total assets	52% *(103%)*	88%	19% *(41%)*
Increase in net profit	121% *(197%)*	86%	51% *(175%)*

** Data from Frater et al. (1995).*

Table 6-3 shows the future expectations of the three groups of companies in terms of their positions in five years. The figures in the parenthesises are drawn from Frater et al. (1995). For the majority of measures there was a greater sense of optimism amongst the highly innovative companies, than either the moderately innovative or the least innovative groups. While the moderately innovative companies project having greater increases in overall sales and assets this does not translate to as great an increase in net profit. This indicates that the highly innovative companies, rather than looking at doing things bigger, are focused on doing thing smarter. When comparing these figures with those from Frater et al. (1995) the highly innovative companies are relatively similar in relation to their future expectations. The least innovative companies in the current study were far less optimistic than the comparable set of companies identified by Frater et al. in 1995. The key differences were in the areas of planned increases in product range, asset growth and subsequent levels of profit that these investments were projected to return.

Table 6-4: Respondent Characteristics

Characteristics	Highly innovative	Moderately innovative	Least innovative
Own the business	63%	37%	63%
Have a tertiary qualification	82%	45%	18%
Time spent managing business (average for group)	88%	79%	67%
Time spent gathering information (average for group)	28%	20%	15%

Overall the highly innovative companies appeared to have senior management that was more highly educated, spent a greater amount of time focusing on managing the business and a greater proportion of their time gathering information. Moderately innovative companies had senior management who were less likely to hold an ownership interest in the organisation than either of the other two groups. The ownership interest may have had an effect on overall levels of innovation, with the moderately innovative group of companies adopting a more risk-averse attitude towards innovation.

6.4 THE ORGANISATIONAL KNOWLEDGE BASE

6.4.1 Organisational Management Systems

The vast majority (82%) of the highly innovative and the moderately innovative companies had a business plan in place. This compared with only 36% of the least innovative organisations. The moderately innovative companies made the greatest use of quality management programmes with 82% of the companies having a quality system in place. This compared to 65% and 55% respectively for the highly innovative and least innovative companies. In relation to information management systems the highly innovative and moderately innovative companies made greater use of formal information management systems, with 83% and 73% of the companies respectively having a system in place. This compared to only 55% of the least innovative companies.

Overall the highly innovative and the moderately innovative companies had management systems of a more formal and structured nature in place.

6.4.2 Information Technology Resources

Table 6.5 shows the areas where there was a difference in the perceived impact of the information technology resources amongst the three groups of companies. Those impacts with a difference of less than 0.5 have been excluded. Overall the highly innovative companies seemed to have had fewer problems and gained a greater benefit from their investments in organisational information technology resources.

Table 6-5: Impact of Organisational Information Technology Resources

Benefits gained from information technology resources	Highly innovative	Moderately innovative	Least innovative
Improved quality of decision making	3.8	**4.2**	3.7
Significantly improved organisational effectiveness	**4.4**	4.0	3.8
Significantly improved customer service	**4.1**	3.6	3.8
Helped to increase sales	**3.4**	**3.4**	2.6
Helped in the provision of new products and services	**3.5**	**3.5**	3.0
Problems resulting from information technology resources			
Have created problems within the organisation	**2.5**	2.9	3.3
Fewer benefits than expected	**2.0**	2.3	2.6

* Bold print indicates the highest average score.

Scale: 1 = Strongly disagree – 5= Strongly agree.

In terms of Internet usage more of the highly innovative and the moderately innovative companies, 27%, than the least innovative companies, 9%, made use of the Internet. Overall the levels for the entire sample were low. It is important to note that the interviews for this study were carried out in 1995, and that it is likely that the levels of understanding and usage of the Internet have changed substantially since then.

6.4.3 Organisational Knowledge Creation Resources

Each of the three groups of companies employed similar levels of technically qualified individuals, between 17% and 25% of employees. Table 6-6 shows the percentage of the companies in each of the groups that made use of business-orientated and technology-orientated business consultants. There was little difference in the level of usage of business-orientated consultant by the three groups. A greater number of the highly innovative companies used technical-orientated consultants than either of the other two groups.

Table 6-6: Use of Consultants

Type of business consultant	Highly innovative	Moderately innovative	Least innovative
Business-orientated	64%	82%	73%
Technical-orientated	55%	36%	27%

Table 6-7 shows a comparison of the three groups of companies in relation to their use of both formal and informal information acquisition practices for each of the information sources. The data is grouped in order of importance to overall business activity as outlined in Table 4-13. The highly innovative and moderately innovative companies made greater use of both formal and informal acquisition methods for a number of the information sources, these included customers, company staff, other companies, exhibitions and conferences, professional bodies, business consultants, government agencies, and libraries.

In addition the moderately innovative companies made greater use of more formal systems for the acquisition of personal experience, patent information and media related information. Overall the least innovative companies were more likely to gather information informally. The moderately innovative companies made the greatest use of both formal and informal information acquisition processes. The highly innovative companies made slightly less use of formal information acquisition methods across the set of information sources, but still had a much greater level of formality that the least innovative companies.

Table 6-7: Use of Both Formal and Informal Information Acquisition Methods

Information sources	Highly innovative	Moderately innovative	Least innovative
Highly important information sources			
Customers	**91%***	**91%**	55%
Personal experience	55%	**73%**	45%
Company staff	64%	**73%**	36%
Moderately important information sources			
Other companies	**73%**	64%	36%
Suppliers	82%	**91%**	73%
Exhibitions/Conferences	73%	**82%**	55%
Trade journals	**82%**	**82%**	45%
Professional bodies	73%	**82%**	55%
Business consultants	**82%**	**82%**	45%
Govt agencies	**100%**	82%	45%
Patent information	64%	**100%**	45%
Information sources of low importance			
Libraries	**73%**	**73%**	27%
Media	36%	**55%**	27%
Family & friends	**36%**	18%	9%
On-line sources	36%	**55%**	27%
Information brokers	36%	**55%**	18%

* *Bold indicates the highest use of both formal and informal information acquisition*

Table 6-8 shows the information sources where there was a difference of greater than 0.5 in relation to the importance rating of the information sources to overall business activity between the three groups of companies. The sources not included in the graph included personal experience, professional bodies, trade journals, and family and friends. All of these sources were rated within 0.5 by each of the three groups of companies. It was assumed that there was no distinguishable difference between these sources.

Table 6-8: Importance of Information Sources to Business Activity

Information source*	Highly innovative	Moderately innovative	Least innovative
Customers (T,C)	4.7	**4.9**#	4.3
Company staff (T)	**4.2**	4.1	3.5
Other companies (T,C)	**3.8**	3.7	2.5
Suppliers (T,C)	**3.6**	3.3	3.0
Exhibitions/Conferences (T,C)	**3.6**	3.5	2.6
Govt agencies (C)	2.5	**3.1**	2.2
Libraries (C)	2.2	**2.8**	2.1
Patent information (C)	2.1	**3.6**	2.0
Media (C)	1.9	**2.7**	2.4
On-line sources (C)	1.9	**2.7**	1.8
Information brokers (C)	1.8	**2.8**	1.5

** T= Tacit knowledge transfer; C=Codified knowledge transfer*

 # Bold indicates the highest use of both formal and informal information acquisition

Scale: 1 = Not important – 5 = Vitally important

The highly innovative and moderately innovative companies rated customers, company staff, other companies, suppliers, and exhibitions and conferences as more important to overall business activity that the least innovative companies. These sources required a mix of both tacit and codified transfer methods. The moderately innovative companies rated the highly codified sources of information, such as government agencies, libraries, patent information, the media, online sources and information brokers higher than the highly innovative or the least innovative companies. Overall the moderately innovative companies relied on a wider set of predominantly codified information sources than the highly innovative companies who placed a greater importance on information sources with a strong tacit component. The least innovative companies on the whole placed a lesser importance on their overall information sources in relation to business activity than either of the other two groups.

6.5 ORGANISATIONAL KNOWLEDGE CREATION

6.5.1 Organisational Attitudes to Product Development

There was a small difference in the rating of importance of product development to the organisations, with the highly innovative companies giving it the highest overall rating. The highly innovative companies also made greater use of a formal product development process than either the moderately innovative or the least innovative companies.

Table 6-9: Organisational Importance and Use of Product Development

Importance and use of Product Development	Highly innovative	Moderately innovative	Least innovative
Importance of product development to the organisation	4.5	4.3	4.1
Use of a formal product development process	73%	55%	27%

Scale: 1 = Not important – 5 = Vitally important

6.5.2 Importance and Performance of Product Development Activities

Table 6-10 shows the relative importance and the percentage of companies that made use of the set of 14 product development-related activities. These activities were based on a product development process model developed by Cooper and Kleinschmidt (1986).

Table 6-10: Importance and Performance of Product Development Activities

Product development Activities	Most innovative	Moderately innovative	Least innovative
Pre-development analysis activities			
Initial screening	3.1* (55%#)	3.6 (91%)	3.5 (91%)
Preliminary market assessment	4.0 (91%)	3.8 (82%)	3.5 (82%)
Preliminary technical assessment	3.5 (82%)	3.7 (91%)	3.9 (91%)
Detailed market research	2.6 (55%)	3.0 (55%)	2.8 (64%)
Financial feasibility study	4.1 (91%)	4.0 (82%)	2.9 (64%)
Product design and testing activities			
Prototype design	3.8 (82%)	4.1 (100%)	4.4 (91%)
In-house testing	3.6 (73%)	3.5 (91%)	3.5 (82%)
Consumer testing	3.5 (73%)	4.3 (82%)	3.2 (64%)
Detailed design	4.2 (91%)	4.5 (100%)	4.1 (82%)
Trial production	2.9 (64%)	4.5 (91%)	3.1 (64%)
Test market	2.6 (55%)	4.0 (73%)	2.9 (55%)
Product commercialisation activities			
Pre-launch business analysis	2.6 (55%)	3.2 (55%)	2.7 (36%)
Production start-up	3.7 (91%)	3.9 (82%)	3.7 (82%)
Market launch	3.2 (64%)	3.8 (73%)	3.4 (73%)

** Scale: 1 = Not important – 5 = Vitally important*

 # Percentage of companies using activity

Pre-Development Analysis Activities

Overall the three groups of companies gave similar importance ratings and performed the majority of the pre-development business activities at relatively similar levels. The two exceptions were the initial screening and financial feasibility study activities. The initial screening activity was rated as less important and performed by a lesser percentage of the highly innovative companies than either of the other two groups. Also, the least innovative companies placed a lower importance and a lesser percentage of these companies undertook a financial feasibility study.

Product Design and Testing Activities

Overall the three groups of companies gave similar importance ratings and performed the majority of the product design and testing activities at relatively similar levels. The two exceptions were trial production and test marketing. The trial production activity was rated as less important and performed by a lower percentage of both the highly innovative and the least innovative companies. These same two groups placed a lower importance and a lesser percentage undertook test marketing.

Product Commercialisation Activities

Again the three groups of companies gave similar importance ratings and performed the majority of the product commercialisation activities at relatively similar levels. The only exceptions were the pre-launch business analysis and the market launch activities. This activity was rated as less important and was performed by a lower percentage of the least innovative companies than either of the other groups. The highly innovative companies placed a lesser importance and less frequently undertook a market launch than either of the other two groups.

The average number of activities performed by each of the three groups reinforces these importance rating scores and the relative performance levels of the product development activities by the three groups. The moderately innovative companies performed on average just over one more activity than either the highly innovative companies or the least innovative companies. These results are shown in Table 6-11.

Table 6-11: Average Number of Product Development Activities Performed

	Highly innovative	Moderately innovative	Least innovative
Average number of activities	10.2	11.5	10.2

Overall the moderately innovative companies placed a greater importance on, and performed on average a greater number of, product development activities than either the highly innovative or the least innovative companies. The least innovative companies had far less of a focus on the financial aspects of the product development process than either of the other two groups. This is reflected in the fact that this group gave the financial feasibility and pre-launch business analyses activities the lowest ratings of the three groups. The highly innovative companies took a higher risk approach to their product development activities. This group rated the initial screening, trial production and test market activities lower than either of the other two groups. The low rating given to the initial screening activity might reflect a more open policy to accepting and exploring new product ideas. The lower rating of the other two activities, trial production and test marketing, might reflect a greater drive to launch products onto the market. Overall the highly innovative companies introduced a far greater number of both new and improved products than either of the other two groups. This group seems to have adopted a more product-focused development process where continuous product improvement is viewed as an essential aspect of that process.

6.5.3 Information Resources for Product Development

Overall the highly innovative companies (4.3) and the moderately innovative companies (4.2) rated their information resources as more valuable in relation to their product development activities than the least innovative companies (3.8).

Table 6-12 shows the relative use that the three groups of companies made of their information sources in relation to product development. The figure in the parenthesis is the average importance rating given for that source in relation to its importance to overall business activity. The sources where there was no real difference between the three groups were professional bodies, media, trade journals, information brokers and in-house sources. All of these sources were rated within 0.5 by each of the three groups of companies. These are not shown in the table.

Table 6-12: Information Usage for Product Development

Information Source	Highly Innovative	Moderately Innovative	Least Innovative
Customers (T,C)	**4.3* (4.7#)**	3.7 (4.9)	3.9 (4.3)
Company staff (T)	**4.0@ (4.2)**	3.5 (4.1)	3.3 (3.5)
Suppliers (T,C)	**3.5 (3.6)**	2.5 (3.3)	2.5 (3.0)
Exhibitions/Conferences (T,C)	**3.3 (3.6)**	3.0 (3.5)	2.4 (2.6)
Other companies (T,C)	**3.2 (3.8)**	**3.2 (3.7)**	2.2 (2.5)
Business consultants (T,C)	**2.6 (2.5)**	2.5 (3.0)	1.7 (2.6)
Family & friends (T,C)	**2.4 (2.4)**	2.0 (2.4)	1.9 (2.2)
Libraries (C)	2.0 (2.2)	**2.3 (2.8)**	1.7 (2.1)
Govt agencies (T,C)	**1.9 (2.5)**	**1.9 (3.1)**	1.5 (2.2)
Patent information (C)	1.8 (2.1)	**2.6 (3.6)**	1.9 (2.0)

* *Scale: 1 = Not at all – 5 = All the time*

Scale: 1 = Not important – 5 = Vitally important

@ *Bold indicates the highest use of product development activity*

Overall the highly innovative companies used a greater range of information sources in relation to their product development activities. This group also placed a greater emphasis to tacit-orientated sources that existed both within and outside of the company. The moderately innovative companies made use of a narrower set of information sources when compared to the highly innovative companies. The set of information sources used by the moderately innovative companies also placed more emphasis on codified sources such as patent information and libraries where they were the highest user group. The least innovative companies overall placed a lower importance on their information sources in relation to their product development activities when compared to the other two groups.

The moderately innovative companies made less use of their information sources in relation to product development activity, as compared to the importance they placed on those sources in relation to their overall business activity. While the moderately innovative companies had a fairly well developed knowledge base, this knowledge base was not being effectively applied to their product development related activities.

Conversely the highly innovative companies were utilising their knowledge base more readily in relation to their product development activities.

6.6 AN OVERVIEW OF ORGANISATIONAL PRODUCT INNOVATION

There was a clear gap in performance between the least innovative companies and both the other groups. On average these companies were smaller in size, had a lower level of net profit, and exported a lower percentage of their overall production. In relation to future expectation the least innovative companies were the most pessimistic group, they also had the lowest level of tertiary qualifications amongst their senior management and their organisational management and production systems were the least developed. **Overall the least innovative companies placed a lower value on their information resources than either of the other two groups, they had less formal systems in place for information acquisition, and they also made only limited use of a formal product development process.** While this group performed a similar number of product development activities to the highly innovative companies there was far less of a focus on product development activities within these companies. The success rating of the products produced was also lower than for either of the other groups.

The moderately innovative and highly innovative companies were similar in size, had a marginally higher level of net profit, utilised quality systems more readily, valued their information resources at a higher level for overall business activity, had more formal systems in place for the acquisition of information and placed greater importance and performed a greater average number of product development activities. A number of previous studies have reported that the use of some type of formal product development process is a key determinant of product success (Booz, Allen and Hamilton, 1968; Booz, Allen and Hamilton, 1982; Griffin, 1997; Mercer Management Consulting, 1994). Over two-thirds of the highly innovative companies reported using some type of formal product development process. Only just over half of the moderately innovative companies, and under one-third of the least innovative companies, made use of a formal product development process. These results appear to support the conclusions of the previous research. **The use of a formal product development process does result in higher levels of product innovation.**

Although the moderately innovative companies used a similar set of information resources to the highly innovative companies they did not apply these to their product development activities as readily as the highly innovative companies. Another key distinction was the use by the highly innovative companies of more tacit-orientated information. Previous studies of innovation, technology transfer and technology diffusion have also identified this link between innovation and tacit knowledge (Dosi, 1988; Nonaka and Takeuchi 1995; Rosenberg, 1976, 1982)

Overall the moderately innovative companies had a slightly more formal range of management systems and practices in place than the highly innovative companies, but despite these more formal systems and practices the moderately innovative companies were not producing the innovative results. **In relation to future outlook the moderately innovative companies took a more conservative view of their future prospects. This more conservative outlook was also reflected through their focus on product improvements rather than new product development. The highly innovative companies out-performed both the other groups in relation to the numbers of both new and improved products introduced over the last five years.**

The highly innovative companies were more optimistic in their future outlook. Frater et al. (1995) identified a similar optimism amongst the highly innovative companies in their recent study of New Zealand's innovation environment. **This more optimistic vision of company future was a key driver of the highly innovative companies' innovative activity. These highly innovative organisations were also more likely to take risks in the pursuit of innovative results.**

Over the last five years the highly innovative companies had introduced an average of 25.7 new products, compared to 8.5 and 8.4 respectively for the moderately innovative and least innovative companies. This compares to the 16.4 reported by Frater et al. and 4.2 per year (21 over five years) reported by Kerr. A recent US study reported an average of 37.5 over a five year period (Page, 1993). **Overall it would seem that New Zealand companies, even those that were classified as highly innovative, are performing at below international levels in terms of the numbers of new products**

they are introducing. This less intensive new product development activity could perhaps be explained by the generally smaller size of the average New Zealand enterprise.

The highly innovative companies reported a lesser average level of overall success for their products over the past five years, 4.0 as compared to 4.6 (1 being "most failed" and 5 being "majority successful") the moderately innovative companies. The average success rate reported by Kerr (1995) was 3.9 for the same period. Given the rate at which the highly innovative companies were introducing new products a slightly higher level of product failure is perhaps acceptable. The least innovative companies indicated a success level of only 3.5 for the new products that had been introduced in the last five years.

A clear link existed between the level of the product development processes and activities and the level of product innovation within the companies. However, the product development processes used by the highly innovative companies differed from the traditionally prescribed stage-gated processes such as Cooper and Kleinschmidt's (1986) 13-activity model. **The highly innovative companies utilised a shorter development process that placed a lower emphasis on the screening of ideas and on the performance of trial production and test marketing activities. These companies were focused on launching products onto the market at the earliest possible time.** The moderately innovative group of companies appeared to follow what was the more traditional approach to product development, making use of a broader range of product development activities as part of their product development processes. But overall, this group of companies lacked the intensity and drive to introduce new products that the highly innovative companies demonstrated.

Overall, the key characteristics that distinguished the highly innovative companies that participated in the study were:

- **a greater degree of formal business planning;**
- **a greater optimism for their company's overall position in five years;**
- **better utilisation of both internal and external-based tacit knowledge;**
- **a more strategic approach to information acquisition;**
- **a greater use of formal product development processes;**

- **a more intensive product development programme;**
- **a shorter product development process; and**
- **better application of the organisational knowledge base for product development activities.**

7. THE KNOWLEDGE CREATING COMPANY: CONCLUSIONS

7.1 INTRODUCTION

Organisational knowledge creation is a key driver of innovation and competitive advantage. The ability of a company to successfully create new knowledge and embody this knowledge into new products, processes, or services is critical to the ongoing survival of a company. Organisational product development activities and practices interplay with the organisational knowledge base to produce these results. The broad objective of this research was to investigate current knowledge creation processes and practices utilised by New Zealand manufacturers. The methodology used involved a series in-depth interviews, conducted with senior managers of a group of 33 manufacturing enterprises in the Wellington and Manawatu regions. Due to the emerging nature of the subject of knowledge creation the interviews were exploratory in nature. The small sample size means that only indicative recommendations have been made in relation to the research results.

The two hypothesises proposed for the study were:

> **H_1:** That a positive relationship exists between the level of product innovation and the level of product development processes and activities within the companies.
>
> **H_2:** That a positive relationship exists between the level of product innovation and extent of the knowledge base within the companies.

The companies that participated in the study were ranked in relation to their innovativeness with reference to their knowledge creation activities. The 33 companies were then separated into three groups, the highly innovative, the moderately innovative and the least innovative companies.

7.2 PRODUCT DEVELOPMENT: THE ENGINE OF KNOWLEDGE CREATION

This study explored a number of elements relating to organisational product development processes and practices. The aim was to build a picture of the companies' product development behaviours and identify the key information resources that contribute to the companies' knowledge creation activities.

The majority of the companies saw product development as an important organisational activity, but at the same time only half of the companies made use of a formal product development process. This finding is consistent with recent studies of companies in the U.S., where 60% and 56% respectively reported using a formal product development process (Griffin, 1997 and Page, 1993). The highly innovative companies in the current study made greater use of a formal product development process than either of the other two groups. This supports the view that a link exists between the use of a formal development process and the level of product innovation within an organisation. This relationship has been previously identified by a number of authors (Booz, Allen and Hamilton, 1968; Booz, Allen and Hamilton, 1982; Griffin, 1997; Mercer Management Consulting, 1994).

The most important and most frequently used product development activities were related to the physical design and manufacture of a product, and on assessing the viability of a product concept in the early development stages. The activities that were least frequently used were notable in that they all focussed on intangible elements of the product development process: i.e. test marketing, detailed market research and pre-launch business analysis. These results are consistent with previous studies (Cooper and Kleinschmidt, 1986; Kerr, 1994; Sanchez and Eloa, 1991) where the focus of companies' product development activities was on a similar set of tangible product development activities. This skewed focus towards tangible activities is understandable as the intangible activities are not strictly required for the completion of a product, although they have been shown to significantly improve the overall likelihood of the success of that product (Cooper and Kleinschmidt, 1986).

The product development processes used by the highly innovative companies differed from the traditionally prescribed stage-gated processes such as Cooper and

Kleinschmidt's (1986) 13-activity model. The highly innovative companies utilised a shorter development process that placed a lower emphasis on the screening of ideas and the performance of trial productions and test marketing activities. These highly innovative companies were focused on launching products onto the market at the earliest possible time. The lower emphasis on the initial screening activity may reflect a willingness by these companies to explore a greater number of initial ideas in the early stages of their product development activities, while the lower levels of test marketing and trial production might indicate a greater drive to get products to market as soon as possible.

Conversely, the moderately innovative group of companies appeared to follow what was a more traditional approach to product development, making use of a broader range of product development activities as part of their product development processes. But overall the moderately innovative companies lacked the development intensity of highly innovative companies introducing a far lower number of both new and improved products over the past five years.

While the highly innovative companies had introduced a greater number of both new and improved products over the last five years than either of the other two groups their reported level of product success was slightly less than the moderately innovative companies in the study. It is possible that the shorter product development process that the highly innovative companies have adopted is responsible in part for this lower level of success. The lack of screening of ideas and a lower emphasis on test marketing and trial production are the likely causes of these lower levels of product success.

The Relationship Between Product Innovation and Product Development Activities

The first hypothesis of this thesis proposed:

> **H_1:** That a positive relationship exists between the level of product innovation and the level of product development processes and activities within the companies.

Overall there does appear to be a positive relationship between these two elements. Just over two-thirds of the highly innovative companies in the study reported making use of a formal product development process, this compared to just over half of the moderately innovative companies and less than one-third of the least innovative companies.

The highly innovative companies also out-performed both the other groups in relation to the numbers of both new and improved products introduced over the last five years. Also, the planned increase in product range by the highly innovative companies over the next five years was double that of the moderately innovative companies and just under 10 time greater than that for the least innovative companies.

Both the highly innovative and the moderately innovative companies had product development processes and practices in place that were more formal, and focused on a broader range of activities, than the least innovative group of companies in the study.

This hypothesis is tentatively accepted.

7.3 THE ORGANISATIONAL KNOWLEDGE BASE

The knowledge base of an organisation consists of both tacit and codified knowledge resources as well as describing the management practices and production systems that exist within a company. Elements of the organisational knowledge base studied as part of this research included: an overview of organisational management, production practices and systems; an exploration of organisational information technology resources; and an overview of the information and knowledge resources utilised by the companies for knowledge creation.

Organisational Management and Production Practices

The vast majority of the companies saw themselves either growing or shifting their business orientation in the future. But, only two-thirds of the companies had a business plan in place. The least innovative companies were half as likely to have a business plan as either the highly innovative or moderately innovative companies.

Many of the companies in the study were planning to expand their business activities but had no strategic context for these expansion activities. Essentially they had no road map for where their organisation was heading. If they don't know where they were going these companies are far less likely to reach a desired state or destination in the future.

Overall the companies' management, marketing and support systems were updated with a greater frequency than their technology and production systems. This is likely due to the higher costs of updating technology or production systems as compared to the "softer" management, marketing and support systems within the organisation. Overall, the highly innovative and moderately innovative companies were better equipped, both technically and also in terms of having more up-to-date management and support infrastructures than the least innovative group of companies. When comparing these results with those reported by Frater et al. (1995), who undertook a study of New Zealand's innovation environment, the companies in the current study had management systems and plant that were less up-to-date. A possible explanation for this might be that the current study was undertaken with companies in the Wellington and Manawatu regions, while Frater et al. looked at companies across the whole of New Zealand. This difference in sample population might explain the variance between the two studies.

Organisational Knowledge Resources

The companies had, on average, 20% of employees who held a technically-based qualification. Companies with less than fifty people were more likely to have a greater proportion than this. The number of technically qualified individuals with the organisation did not differ with company innovativeness. Kerr (1994) reported a comparable figure of 19% of employees holding a technical qualification in his study of the product development practices of a group of New Zealand manufacturing enterprises.

The vast majority of companies made use of business consultants, with these consultants being more likely to be business-orientated, rather than technically orientated. The highly innovative companies made greater use of technical-orientated consultants than either of the other two groups. There was a greater willingness amongst the highly innovative companies to import technical skills and competencies into the organisation to solve a problem.

Tacit-orientated information sources were identified as being crucial to the companies' overall business activities. Customers, along with personal experience and company staff were identified as the three most important information sources to the companies' overall business activity. These sources have been identified as key sources in a number of previous studies (Chalmers, 1994; Gnomes, 1998; Johnston, 1991). As the information sources decreased in importance they became more codified in nature.

The highly innovative and moderately innovative companies made greater use of formal information acquisition methods across all of their information sources. This more formalised behaviour points to a more strategic approach being adopted in relation to their information acquisition activities. This counters previous research results that have pointed to a high degree of informal acquisition behaviour amongst companies (Chalmers, 1994; Gnomes, 1998; Roberts and Clifford; 1986, Sharkey, 1992). The least innovative group of companies utilised this more informal approach to information acquisition far more prolifically.

Overall the companies placed a greater value on their tacit-based knowledge. A barrier still seemed to exist in relation to a lack of tools to adequately manage tacit knowledge within the organisations. All three groups of companies were at most only moderately satisfied with their current information management systems. The high degree of reliance on tacit-based knowledge might also explain the relatively low levels of contribution that the companies' current information technology resources were making to their product development activities. The information technology resources were focused on the capture and processing of codified information. This codified information was making less of a contribution to the companies' knowledge creation activities than that being made by the tacit knowledge.

Use of Knowledge Resources in Product Development Activities

The majority of the companies rated their information resources as either very or vitally important to the overall success of their product development activity. Both the highly innovative and moderately innovative companies placed a greater value on their information resources in relation to their product development activities than the least innovative companies.

Heavily used information sources in relation to product development activities included personal experience, customers, company staff and in-house sources. These sources were mostly internally focused and required high levels of tacit knowledge transfer. The moderately used sources all existed outside of the companies, and were focused on specialised information sources which were either product or industry specific. These sources required a mix of tacit and codified knowledge transfer. The set of least used sources were highly codified in nature and covered a broad range of information fields, the majority of which were non-industry specific, and more generally focused.

These levels of relative usage are consistent with those identified in previous research (Frater et al. 1995; von Hippel, 1988). In all these studies there was a strong focus on internal information sources and on external sources that are highly focused and provided information that was directed towards industry or production specific issues.

Knowledge and Innovation

The highly innovative companies made greater use of information resources in relation to their product development activities than either of the other two groups. In addition this group of companies made greater use of tacit-oriented knowledge. The highly innovative companies also made the most effective use of their overall knowledge base in relation to their product development activities. Both of the other groups were under-utilising their knowledge base in relation to their knowledge creation activities.

Gnomes (1998) suggested that overall, companies are utilising only a narrow range of the information resources available to support their business activities. While this is true for the moderately innovative and least innovative groups of companies in the study, the highly innovative companies were utilising a wider set of information sources than either of the other two groups and these information resources were making a greater contribution to their overall knowledge creation activities.

The relationship between product innovation and the organisational knowledge base

The second hypothesis proposed:

> **H_2:** That a positive relationship exists between the level of product innovation and extent of the knowledge base within the companies.

Overall there did appear to be a positive relationship between these two elements. The highly innovative and moderately innovative companies had stronger technical, management, support and planning infrastructures than the least innovative group of companies. The highly innovative companies placed a greater emphasis on tacit-orientated information. They also utilised their organisational knowledge base more effectively than either of the other two groups in relation to their knowledge creation activities. Overall the knowledge base of the highly innovative companies was making a more significant contribution to the companies' product innovation.

This hypothesis is tentatively accepted.

7.4 THE KNOWLEDGE CREATING COMPANY: OVERALL CONCLUSIONS

Knowledge creation is a complex activity that involves the distilling of many pieces of discrete knowledge in a continuous spiral in which knowledge is constantly converted from its tacit form, for example, as a product concept or idea, to its codified form as a market research report that evaluates that product concept. The final result of this process is a product, which is the codified embodiment of a series of discrete pieces of organisational knowledge that have been captured and transformed through the process of knowledge creation.

This study explored the key characteristics of the knowledge creation process amongst a group of 33 manufacturing organisations. This group was split in three in terms of their innovativeness and the characteristics that distinguished the highly innovative companies from the rest were:

- a greater degree of formal business planning;
- a greater optimism for their company's overall position in five years;
- better utilisation of both internal and external-based tacit knowledge;
- a more strategic approach to information acquisition;
- a greater use of formal product development processes;
- a more intensive product development programme;
- a shorter product development process; and
- better application of the organisational knowledge base for product development activities.

Overall, the highly innovative companies demonstrated a greater willingness to take on the challenge of developing new products and to expanding and growing their markets and their business. Perhaps as much as anything it appeared to be this group's attitude to innovation that separated them from the other companies in the study. The highly innovative companies were less formal in terms of their organisational management systems and practices than the moderately innovative companies in the study, but were achieving far greater levels of product innovation. One point to note is the slightly lower level of reported product success amongst the highly innovative companies. This is likely attributable to the shorter product development process that these companies were using, although this is not conclusive.

An important finding of the research was the high value that all the companies placed on their tacit-based knowledge resources. These resources were making by far the greatest contribution to the companies' knowledge creation activities, but at the same time the companies had no real systems in place to manage this valuable resource.

7.5 FUTURE DIRECTIONS

Based on the above conclusions the following are suggested areas for further study.

- The impact of what appears to be an emerging shorter product development process on overall levels of product success.
- The tools and practices that the companies are applying to manage their tacit-based knowledge assets.

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APPENDIX 1: SURVEY QUESTIONNAIRE

Information Resource Sophistication and its Impact on New Product Development in New Zealand's Manufacturing Sector

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Introduction

Before we begin, be assured that everything you say will be treated in the strictest confidence, and will remain completely confidential.

First a little about the survey. It has been designed to gain an insight into the way in which your company gathers and uses information and the way in which information resources affect your ability to develop successful new products.

Section A: Company Activities & Demographics

Location by region: ______________________
Company Name: ________________________
Coding Number: ________________________

Q1. What is your company's main business activity?

Q2. How long has the company been operating in its present form? ____________________

Q3. What direction do you see the business taking in the future? _______________________

Q4. How many employees does your company currently have including yourself? _______

Q5. How many technical or tertiary qualified employees do you have within the company?

Q6. Looking at showcard A in which of these functional areas does your company operate? How many employees are involved in each area?

	Operate	No of Employees
Administration	☐	_____
Design	☐	_____
Marketing	☐	_____
Management	☐	_____
Production	☐	_____
Quality management	☐	_____
Research and development	☐	_____
Sales	☐	_____

Q7. Does your company make use of external business consultants? Please list the consultants you use?

Q8. What is the legal status of your company?

Partnership ☐
Sole trader ☐
Limited liability ☐

Q9. Does your company export products to any overseas markets

Yes ☐
No ☐ skip to 12

Q10. What are your main export markets? ______________________________

Q11. What percentage of production do you export? ______________________________

Q12. Does your company have a written business plan? (A document which contains an analysis of the firm's current position, where it would like to be in the future, and how it plans to get there.)

Yes ☐
No ☐

Why? ______________________________

Q13. Looking at showcard B please indicate the category into which your company's net profit (before tax) fell during the last financial year?

0 - $49,000 ☐
50,000 - 99,000 ☐
100,000 - 499,999 ☐
500,000 - 1,000,000 ☐
Greater than 1,000,000 ☐

Q14. Please describe the management structure your company operates under? (diagram)

Q15. Does your company have a formal quality management programme in place?

Yes ☐
No ☐ If no then skip to 18

Why? ____

Q16. Please describe this programme? ______________________________

Q17. What benefits has the quality management programme provided your company with?

Q18. Looking at showcard C please rate the functional areas presented in terms of their relative importance to the success of your overall business.

	Not important	Slightly important	Moderately important	Very important	Vitally important
Administration	1	2	3	4	5
Design	1	2	3	4	5
Marketing	1	2	3	4	5
Management	1	2	3	4	5
Production	1	2	3	4	5
Quality management	1	2	3	4	5
Research and development	1	2	3	4	5
Sales	1	2	3	4	5

Q19. Looking at showcard D, for the following assets please rank them 1-6 in their order of importance to the overall success of your business?

	Rank
Plant and Machinery	______
Staff	______
Customers	______
Business information	______
Information Technology Resources	______
Raw materials	______

Other ____

____

Q20. Using showcard E indicate to the nearest 10% where you expect your company to be in 5 years, in terms of:

	Percentage up	*or*	percentage down	*or*	no change
Total sales					☐
Export sales					☐
Product range					☐
Employment					☐
Total assets					☐
Net profit (before tax)					☐

Q21. How many completely new product lines have been introduced in the last 5 years?

Q22. How many existing products have been significantly improved in the last five years?

Q23. Using Showcard F approximately what proportion of your annual sales are made up of:

Completely new products introduced in the last 5 years

Products significantly improved in the last five years

Long-established products (including minor improvements)

Q24. Looking at showcard G how successful have the majority of new products introduced during the last 5 years by your company been?

	Most failed		Mix of success/failure		Highly successful
Success of products	1	2	3	4	5

Q25. Using showcard H to what extent have your company's basic technology and production process changed as compared with:

	not at all	A little	Substantially	Completely
One year ago	☐	☐	☐	☐
Five years ago	☐	☐	☐	☐

Q26. Again using showcard I to what extent have your management, marketing, support, and related systems changed as compared with:

	not at all	A little	Substantially	Completely
One year ago	☐	☐	☐	☐
Five years ago	☐	☐	☐	☐

Q27. Using showcard J how does your current plant equipment compare with the best available technology?

Do you consider it -

Fully up to date	2-4 years behind	5-10 years behind	More than 10 years behind
☐	☐	☐	☐

Section B: Product Development Activities within the Company

Q1. Looking at showcard K how important is the activity of product development to the overall success of your company?

	Not important	Slightly important	Moderately important	Very important	Vitally important
Importance of product development	1	2	3	4	5

Why? ____

Q2. Does your company use a formal process in the development of its products?

Yes ☐
No ☐

Why? ____

Q3. Please describe the stages, either formal or informal your company goes through when developing a product? ____

Q4. What are the three main sources of new product ideas for your company? ____________

-
-
-

Q5. Who is primarily responsible for the management of product development activities within your company? ____

Q6. Please rate each of the activities on showcard L in terms of their importance to your overall product development programme.

	Not important	Slightly important	Moderately important	Very important	Vitally important
Initial screening	1	2	3	4	5
Preliminary market assessment	1	2	3	4	5
Preliminary technical assessment	1	2	3	4	5
Detailed market research	1	2	3	4	5
Financial feasibility study	1	2	3	4	5
Prototype design	1	2	3	4	5
In-house testing	1	2	3	4	5
Consumer testing	1	2	3	4	5
Detailed Design	1	2	3	4	5
Trial production	1	2	3	4	5
Test market	1	2	3	4	5
Prelaunch business analysis	1	2	3	4	5
Production start-up	1	2	3	4	5
Market launch	1	2	3	4	5

Q7. What are the main problems/barriers that inhibit your company's product development activities?

Q9. What factors are required to encourage good product development within an organisation?

Section C: Information Resources within the Company

Information is an intangible asset. This section aims to identify your company's approach to managing its information resources.

Information resources can be broken down into three areas:

The acquisition of Information
The management of Information
The use of Information

The Acquisition of Information

Information can be acquired by two means, formally or informally. Informal information is not sought and not the result of a predetermined strategy. Formal information involves a recognised need for business information. Formal steps are then taken to meet this need.

Q1. Using showcard M please indicate for each source whether information is collected informally, formally or both?

	Both	Informally	Formally	N/A
Personal experience	☐	☐	☐	☐
Customers	☐	☐	☐	☐
Suppliers/Sales reps	☐	☐	☐	☐
Trade associations/ Professional bodies	☐	☐	☐	☐
Government Agencies	☐	☐	☐	☐
Libraries	☐	☐	☐	☐
Media	☐	☐	☐	☐
Trade journals	☐	☐	☐	☐
Exhibitions/Trade material/ Conferences	☐	☐	☐	☐
Business Consultants	☐	☐	☐	☐
Family & friends	☐	☐	☐	☐
Company staff	☐	☐	☐	☐
Other companies/competitors	☐	☐	☐	☐
Patent information	☐	☐	☐	☐
Information brokers	☐	☐	☐	☐
On-line sources	☐	☐	☐	☐

Other ____

Q2. Thinking about these information sources please indicate using showcard N the relative importance of each to your business activity?

	Not important	Slightly important	Moderately important	Very important	Vitally important
Personal experience	1	2	3	4	5
Customers	1	2	3	4	5
Suppliers/Sales reps	1	2	3	4	5
Trade associations/ Professional bodies	1	2	3	4	5
Government Agencies	1	2	3	4	5
Libraries	1	2	3	4	5
Media	1	2	3	4	5
Trade journals	1	2	3	4	5
Exhibitions/Trade material/ Conferences	1	2	3	4	5
Business Consultants	1	2	3	4	5
Family & friends	1	2	3	4	5
Company staff	1	2	3	4	5
Other companies/competitors	1	2	3	4	5
Patent information	1	2	3	4	5
Information brokers	1	2	3	4	5
On-line sources	1	2	3	4	5

Other ____

Q3. Who is responsible for the information sourcing in your company? ________________

Q4. What percentage of time do you personally spend gathering information? ____________

Q5. When developing a new product, in % terms, how much are you willing to spend on the gathering of accurate information? In terms of...

Time? ____

Money? ____

Resources? ____

Q6. What are the three main methods by which information physically enters your company? (Checklist)

Phone ☐
Fax ☐
Mail ☐
Personnel contact ☐
Media ☐

Other ______________________________

Q7. Please outline your understanding of the internet? ______________________

Q9. Does your company use the internet in a business capacity?

Yes ☐ if yes skip to 14
No ☐ If no then skip to 12

Q 10. Please describe the services you use? ______________________

Q 11. Do you plan on expanding your use?

Yes ☐
No ☐
Why? ______________________________

Q12. Do you plan to use the internet as a business tool?

Yes ☐
No ☐

Why/When? ______________________________

The Management of Information

Q13. Does your company have a formal information management system?

Yes ☐
No ☐

Why?

Q14. Please describe the information management system your company uses? ___________

Q15. Who is primarily responsible for the management of information within your company?

Q16. Looking at showcard O please rate your satisfaction with your current information management system?

	Not satisfied	Slightly satisfied	Moderately satisfied	Very satisfied	Extremely satisfied
Satisfaction with current information system	1	2	3	4	5

Q17. Does your company use computers in any capacity?

Yes ☐
No ☐ if not skip to 27

Q18. Please outline the computing equipment your company has? (Checklist)

- CAD ☐
- CAM ☐
- Internet ☐
- Desktop computer ☐
- Modem ☐
- Printer/Plotter ☐
- Lan ☐

Other ______________________________

Q19. For what applications does your company use its computers? (Checklist)

- Word processing ☐
- Accounts ☐
- CAD ☐
- CAM ☐
- Graphics/Design ☐
- Email ☐
- Data transfer ☐
- Payroll ☐
- Sales records ☐
- Database management ☐
- Fax ☐
- Multimedia ☐
- WWW access ☐
- Inventory management ☐

Other ______________________________

Q20. Looking at showcard P what financial investment does your company currently have in computing resources?

- 0 -$19,999 ☐
- $20,000 - $49,999 ☐
- $50,000 - $99,999 ☐
- $100,000 - $499,999 ☐
- $500,000 + ☐

Q21. Using showcard Q please rate the following functional areas in terms of the importance of computing resources to their everyday operation?

	Not important	Slightly important	Moderately important	Very important	Vitally important	N/A
Administration	1	2	3	4	5	☐
Design	1	2	3	4	5	☐
Marketing	1	2	3	4	5	☐
Management	1	2	3	4	5	☐
Production	1	2	3	4	5	☐
Quality management	1	2	3	4	5	☐
Research and development	1	2	3	4	5	☐
Sales	1	2	3	4	5	☐

Q24. When & why did you first acquire your computer systems? ______________________________

Q25. What benefits has your company gained through its computing resources?

- Improved efficiency ☐
- Speedy access to information ☐
- Better planning ☐
- Personnel reductions ☐
- Improved cash flow ☐
- None ☐

Other ____

Q26. The following statements are designed to seek your opinions on the benefits and problems with your computing resources. Using showcard R select the response that best indicates your feeling with regard to each statement.

	Strongly Strongly Disagree	Disagree	Undecided	Agree	Agree
CR have improved the quality of decision making within the company 5	1	2	3	4	
CR have helped in the provision of new products or services 5	1	2	3	4	
The systems have failed to meet some of our requirements 5	1	2	3	4	
The systems have been well worth the investment 5	1	2	3	4	
CR have created problems 5	1	2	3	4	
CR have helped to increase sales 5	1	2	3	4	
So far the systems have been a failure 5	1	2	3	4	
We achieved fewer benefits than expected 5	1	2	3	4	
CR significantly improved organisational effectiveness 5	1	2	3	4	
CR significantly improved customer service 5	1	2	3	4	

Non-use of a computer

Q27. Looking at showcard S, how likely is your company to acquire a computer during the next 12 months?

	Not at all likely		Likely		Extremely likely
Likelihood to acquire a computer	1	2	3	4	5

Q28. Have you personally had any experience with computers?

No personal experience ☐
Some Experience ☐

Q29. Has anyone else in the company to the best of your knowledge had experience with computers?

No personal experience ☐
Some Experience ☐

Q30. The following statements are designed to gain your opinions on computers. Using showcard T select the response that best indicates your feeling with regard to each statement.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I can see a need for a computer in my firm	1 2	3	4	5	
I know very little about computers	1 2	3	4	5	
My firm could afford a computer	1 2	3	4	5	
A computer could help me manage the firm	1 2	3	4	5	
I do not have the time to learn about computers	1 2	3	4	5	
The firm is too small for a computer	1 2	3	4	5	
A computer could save money for the firm	1 2	3	4	5	
The operations of the company are too complex to be computerised	1 2	3	4	5	
Computers waste more time and effort than they save	1 2	3	4	5	

The Use of Information

Q31. Using Showcard U indicate the value of your company's information resources in relation to the success of product development activities?

	Not at all valuable		valuable		Extremely valuable
Value of information resources	1	2	3	4	5

Q32. Using showcard V please indicate the frequency with which your company use each source with regard to new product development?

	Not at all		Moderate use		All the time
Personal experience	1	2	3	4	5
Customers	1	2	3	4	5
Suppliers/Sales reps	1	2	3	4	5
Trade associations/ Professional bodies	1	2	3	4	5
Government Agencies	1	2	3	4	5
Libraries	1	2	3	4	5
Media	1	2	3	4	5
Trade journals	1	2	3	4	5
Exhibitions/Trade material/ Conferences	1	2	3	4	5
Business Consultants	1	2	3	4	5
Family & friends	1	2	3	4	5
Company staff	1	2	3	4	5
Other companies/competitors	1	2	3	4	5
Patent information	1	2	3	4	5
Information brokers	1	2	3	4	5
On-line sources	1	2	3	4	5
In-house sources	1	2	3	4	5

Q33. Once information enters your company what happens to it? ______________________

Q34. How is information distributed/communicated throughout the company? ____________

Q35. Once information has been used what happens to it? ______________________

Section D: Manager Demographics

Q1. Gender

Male ☐
Female ☐

Q2. What is your position within the company at the present time? ________________

Q3. In what year were you born?

19:

Q4. Are you an owner who manages the company, or are you employed to manage the company?

Owner-manager ☐
Employed as a manager ☐

Other ____

Q5. What proportion of your time do you spend on the shop floor? ________________

Q6. What is your highest educational qualification? ________________________

Q7. Looking at showcard W which information sources do you use for each of these product development activities?

General Comments ____

APPENDIX 2: SURVEY QUESTIONNAIRE RESULTS

Section A: Company Activities and Demographics

Q1. What is your company's main business activity?

Main business activity	No.
Consumer	11
Industrial	7
Commercial/Building	15
Total	33

Q2. How long has the company been operating in its present form?

Company ages - in present forms	No.
< 5 yrs.	4
6 - 10 yrs.	3
11 - 20 yrs.	9
21 - 30 yrs.	3
31 - 40 yrs.	7
> 41 yrs.	6
Total	32

Q3. What direction do you see the business taking in the future?

Future business direction	No.
Growth	12
Change	14
Status quo	6
Other	1
Total	33

Q4. How many employees does your company currently have including yourself?

Number of employees	No.
0 to 10	5
11 to 49	15
50 +	13

Q5. How many technical or tertiary qualified employees do you have within the company?

Number of technical / tertiary qualified employees	No.
0 to 5	15
6 to 9	7
10 to 19	2
20 to 29	3
30 +	6
Total	33

Q6. Looking at showcard A in which of these functional areas does your company operate? How many employees are involved in each area?

Not analysed.

Q7. Does your company make use of external business consultants?

Does the company use external consultants	No.
Yes	27
No	6

Q7(b). Please list the consultants you use?

Business consultants used	No.
Business orientated	25
Technical oriented	13

Q8. What is the legal status of your company?

Legal status of company	No.
Partnership	0
Sole trader	0
Limited liability	33

Q9. Does your company export products to any overseas markets

Involved in exporting	No.
Yes	28
No	5

Q10. What are your main export markets?

Main export markets	No.
Australia	26
US	7
China	1
UK/Europe	5
Other Asian	10
Japan	1
South Africa	2
South America	1
South Pacific	5

Q11. What percentage of production do you export?

Percentage of production exported	No.
< 10%	15
11 - 20%	4
20 - 50%	5
50% +	4
Total	28

Q12. Does your company have a written business plan? (A document which contains an analysis of the firm's current position, where it would like to be in the future, and how it plans to get there.)

Does the company have a written business plan :	No.
Yes	22
No	11

Q12(b).

Reason for having business plan	No.
Set direction/Planning/Focus	11
Obtain finance/investment	4
Currently being developed	2
Important, but don't have one	1
Mgt tool	1
Benchmarking	1

Q13. Looking at showcard B please indicate the category into which your company's net profit (before tax) fell during the last financial year?

Company's profit (NPBT) last financial year	*No.*
0 - $49,000	*4*
$50,000 - $99,000	*3*
$100,000 - $499,000	*6*
$500,000 - $1,000,000	*6*
$1,000,000 +	*8*
Refused/Not available	*6*
Total	*33*

Q14. Please describe the management structure your company operates under? (diagram)

Not analysed.

Q15. Does your company have a formal quality management programme in place?

Does company have a formal quality management programme	No.
Yes	22
No	11

Q15(b).

Reasons for having quality management programme	No.
QM essential	1
Too small to be necessary	1
Needed For subcontracting	1
Working towards	4
Customer demand	2
Management	1
Market edge	1

Q16. Please describe this programme?

Description of quality management programme	No.
ISO 9002	12
ISO 9001	9
Other	1

Q17. What benefits has the quality management programme provided your company with?

Benefits the quality management programme has provided the company	No.
Cost reduction/Consistency/Productivity	8
Procedures/Systems	14
Customer satisfaction/Credibility	7
Employee satisfaction/Focused	4
Cultural change	3
None (customer driven)	2

Q18. Looking at showcard C please rate the functional areas presented in terms of their relative importance to the success of your overall business.

Not Analysed.

Q19. Looking at showcard D, for the following assets please rank them 1-6 in their order of importance to the overall success of your business?

Company assets	Average ranking
Staff	1.6
Customers	1.7
Plant/Machinery	3.4
Business information	3.7
Raw materials	4.0
Info tech resources	4.4

Q20. Using showcard E indicate to the nearest 10% where you expect your company to be in 5 years, in terms of:

Expected position in 5 years	Average
Total sales	119%
Export sales	127%
Product range	22%
Employment	40%
Total assets	54%
Net profit	87%

Q21. How many completely new product lines have been introduced in the last 5 years?

How many completely new product lines in the last five years	No.
Zero	3
1 - 5	14
6 - 10	6
11 - 20	4
21 - 50	4
> 51	2
Total	33

Q22. How many existing products have been significantly improved in the last five years?

How many improved existing products in the last five years	No.
Zero	8
1 - 5	9
6 - 10	5
11 - 20	1
21 - 50	3
> 51	7
Total	33

Q23. Using Showcard F approximately what proportion of your annual sales are made up of:

What proportion of annual sales are made up of :	Average
Completely new products (introduced in last 5 yrs.)	27%
Products significantly improved (over last 5 yrs.)	24%
Long established products (with minor improvements)	49%

Q24. Looking at showcard G how successful have the majority of new products introduced during the last 5 years by your company been?

Rating of success of new products introduced in last five yrs.	No.
Most failed	0
	1
Mix of success/failure	8
	13
Majority successful	11

Q25. Using showcard H to what extent have your company's basic technology and production process changed as compared with:

Extent of basic technology/production changes as compared with :	One year ago	Five years ago
Not at all	7	2
A little	16	18
Substantially	10	12
Completely	0	1
Total	33	33

Q26. Again using showcard I to what extent have your management, marketing, support, and related systems changed as compared with:

Extent that management/marketing/support/ related systems have changed as compared with :	One year ago	Five years ago
Not at all	6	4
A little	13	7
Substantially	11	12
Completely	3	10

Q27. Using showcard J how does your current plant equipment compare with the best available technology? Do you consider it

How does the current plant/equipment compare with the best available :	No.
Fully up to date	2
2 - 4 years behind	14
5 - 10 years behind	10
> 10 yrs. behind	6

Section B: Product Develop Activities within the Company

Q1. Looking at showcard K how important is the activity of product development to the overall success of your company?

Rating of the importance of PD to overall success	No.
Not important	0
Slightly important	1
Moderately important	5
Very important	11
Vitally important	16
Total	33

Q2. Does your company use a formal process in the development of its products?

Does the company use a formal product development process	No.
Yes	17
No	16

Q2(b).

What reasons did they have for using a formal PD process :	No.
Consistency/Reliability	2
Structured approach	2
Cost	1
Complexity of process	1
ISO requires process	3
Increases success	1
Resources	2

Q2(c).

What reasons were given for not using a formal process	No.
Only need for testing	1
Used own ideas	1
Used best practice	1

Q3. Please describe the stages, either formal or informal your company goes through when developing a product?

Not Analysed.

Q4. What are the three main sources of new product ideas for your company?

Sources of new product ideas	No.
Market need/Customers	21
Company staff	12
Mags/Literature	7
Overseas	7
Management	5
Conferences/Trade shows	5
Consultants/External sources	5
Competitors products	5
New technology	3
Product improvements	3
Suppliers	3

Q5. Who is primarily responsible for the management of product development activities within your company?

Who is responsible for managing the development process	No.
GM/MD	17
Director	5
Management	13

Q6. Please rate each of the activities on showcard L in terms of their importance to your overall product development programme.

RATING	Not important	Slightly important	Moderately important	Very important	Vitally important	Average
Initial screening	1	7	7	13	5	3.4
Preliminary market assessment	1	4	4	16	8	3.8
Preliminary technical assessment	1	3	9	12	8	3.7
Detailed market research	7	5	10	9	2	2.8
Financial feasibility study	4	1	7	11	10	3.7
Prototype design	0	1	7	13	12	4.1
In-house testing	2	5	9	8	9	3.5
Consumer testing	1	5	7	12	8	3.6
Detailed design	0	1	4	14	14	4.2
Trial production	4	3	8	8	10	3.5
Test market	5	6	7	8	7	3.2
Pre-launch business analysis	4	11	10	2	6	2.8
Production start-up	1	4	6	12	10	3.8
Market launch	2	8	5	9	9	3.5

Q7. What are the main problems/barriers that inhibit your company's product development activities?

What are the main problems / barriers that inhibit PD activities	No.
Resources	31
Finance	13
People	12
Time	9
Ideas/Information	5

Q9. What factors are required to encourage good product development within an organisation?

What factors are needed to encourage good PD in the company	No.
Enterprise resources	11
Management competency	20
Enterprise culture	16

Section C: Information Resources within the Company

Q1. Using showcard M please indicate for each source whether information is collected informally, formally or both?

	Both	Informally	Formally	N/A	Total
Personal experience	18	14	1	0	33
Customers	19	6	7	1	33
Suppliers	18	3	9	3	33
Professional bodies	8	4	15	6	33
Govt agencies	6	1	19	7	33
Libraries	6	6	13	8	33
Media	9	12	4	8	33
Trade journals	13	9	10	1	33
Exhibitions/Conferences	15	7	8	3	33
Business consultants	9	5	14	5	33
Family & friends	7	18	0	8	33
Company staff	14	13	5	1	33
Other companies	13	12	6	2	33
Patent information	3	3	20	7	33
Information brokers	4	3	8	18	33
On-line sources	2	7	11	13	33

Q2. Thinking about these information sources please indicate using showcard N the relative importance of each to your business activity?

	Not important	Slightly important	Moderately important	Very important	Vitally important	Total
Personal experience	0	0	5	9	19	33
Customers	0	1	0	9	23	33
Suppliers	2	7	9	9	6	33
Professional bodies	3	11	12	5	2	33
Govt agencies	5	12	10	3	3	33
Libraries	5	15	10	2	1	33
Media	9	11	7	5	1	33
Trade journals	0	6	20	6	1	33
Exhibitions/conferences	2	11	4	9	7	33
Business consultants	6	7	11	8	1	33
Family & friends	8	13	8	2	2	33
Company staff	2	1	6	13	11	33
Other companies	3	4	11	8	7	33
Patent information	11	4	11	2	5	33
Information brokers	16	6	7	2	2	33
On-line sources	14	4	12	2	1	33

Q3. Who is responsible for the information sourcing in your company?

Who is responsible for information sourcing	No.
Mgt team/Manager/MD	13
Everyone	12
Director	3
Mkt/Sales	2
Other	3

Q4. What percentage of time do you personally spend gathering information?

What percentage of time is personally spent gathering info	No.
< 10 %	11
11 - 30 %	15
31 - 50 %	2
51 - 100 %	2
Didn't know	3
Total	33

Q5. When developing a new product, in % terms, how much are you willing to spend on the gathering of accurate information? In terms of...

Time?

Money?

Resources?

Not analysed

Q6. What are the three main methods by which information physically enters your company?

Not analysed

Q7. Please outline your understanding of the Internet?

Rating of understanding of the Internet	No.
Good	10
Limited	19
None	4
Total	33

Q9. Does your company use the Internet in a business capacity?

Does the company use the Internet in a business capacity	No.
Yes	7
No	26
Total	33

Q 10. Please describe the services you use?

Description of the services used	No.
Information scanning	1
Promotional tool	1
Service delivery	2
Email/file transfer	4

Q 11. Do you plan on expanding your use?

Do they plan on expanding their use of the Internet	No.
Yes	7
No	26
Total	33

Q 11(a).

Reason given for saying yes to above question	No.
Information scanning	4
Communication	4
Lan based access	1
Mkt tool	1

Q12. Do you plan to use the Internet as a business tool?

Do they plan on using the Internet as a business tool	No.
Yes	16
No	7
Maybe	3
Total	26

Q12(a).

Reason given for saying yes to above question	No.
Scanning	6
Communication	3
Competitiveness	1

Q13. Does your company have a formal information management system?

Does the company have a formal info mgt system	No.
Yes	23
No	10

Q14. Please describe the information management system your company uses?

Information management system	Yes	No
Product info	8	2
Business info	13	3
Library	3	1
Other	7	0

Q15. Who is primarily responsible for the management of information within your company?

Who is primarily responsible for info mgt	No.
GM/MD/Mgr	14
Director	4
Mgt (senior)	9
Other	6
Total	33

Q16. Looking at showcard O please rate your satisfaction with your current information management system?

Rating of satisfaction with current info mgt system	No.
Not satisfied	2
Slightly satisfied	4
Moderately satisfied	21
Very satisfied	6
Extremely satisfied	0
Total	33

Q17. Does your company use computers in any capacity?

Does the company use computers in any capacity	No.
Yes	33
No	0

Q18. Please outline the computing equipment your company has? (Checklist)

Not analysed

Q19. For what applications does your company use its computers?

Applications that computers are used for	No.
Admin/Acc/Finance	33
Design/Production	15
Inventory	14
Communications	4

Q20. Looking at showcard P what financial investment does your company currently have in computing resources?

Companies financial investment in computing resources	No.
0 - $19,999	12
20,000 - $49,999	8
50,000 - $99,000	1
100,000 - $499,999	4
$500,000 +	8
Total	33

Q21. Using showcard Q please rate the following functional areas in terms of the importance of computing resources to their everyday operation?

Not analysed.

Q24. When & why did you first acquire your computer systems?

Not analysed.

Q25. What benefits has your company gained through its computing resources?

Benefits gained through computing resources	No.
Essential to business	6
Mgt	8
Efficiency	10
Info access/Timely	11
Productivity	2
None	1
Other	2

Q26. The following statements are designed to seek your opinions on the benefits and problems with your computing resources. Using showcard R select the response that best indicates your feeling with regard to each statement.

Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Has improved the quality of decision making	1	2	4	18	8
Has helped in the provision of new products/services	0	12	4	12	5
Has failed to meet some needs	2	9	5	15	2
Worth the investment	0	1	4	17	11
Has created problems	1	13	7	10	1
Has helped to increase sales	0	13	7	9	4
So far has been a failure	16	15	0	2	0
Has achieved fewer benefits than expected	6	16	7	3	1
Has significantly improved organisational effectiveness	0	1	4	19	8
Has significantly improved customer service	0	4	6	14	9

Q27. Looking at showcard S, how likely is your company to acquire a computer during the next 12 months?

Not applicable to any of the companies.

Q28. Have you personally had any experience with computers?

Not applicable to any of the companies.

Q29. Has anyone else in the company to the best of your knowledge had experience with computers?

Not applicable to any of the companies.

Q30. The following statements are designed to gain your opinions on computers. Using showcard T select the response that best indicates your feeling with regard to each statement.

Not applicable to any of the companies.

Q31. Using Showcard U indicate the value of your company's information resources in relation to the success of product development activities?

Rating of the value of the info resource in relation to the success of PD activities	No.
Not at all valuable	0
	4
Valuable	4
	10
Extremely valuable	15
Total	33

Q32. Using showcard V please indicate the frequency with which your company use each source with regard to new product development?

RATING	Not at all		Moderate use		All the time
Personal experience	0	0	5	11	17
Customers	0	2	7	14	10
Suppliers	6	7	10	7	3
Professional bodies	7	15	6	4	1
Govt agencies	14	14	4	1	0
Libraries	10	15	6	2	0
Media	11	11	9	2	0
Trade journals	3	11	11	8	0
Exhibitions/conferences	6	7	10	5	5
Business consultants	9	13	4	6	1
Family & friends	11	12	6	4	0
Company staff	3	1	8	15	6
Other companies	5	6	13	7	2
Patent information	10	15	3	4	1
Information brokers	21	9	2	1	0
On-line sources	21	6	3	3	0
In-house sources	4	2	6	14	7

Q33. Once information enters your company what happens to it?

Not analysed.

Q34. How is information distributed/communicated throughout the company?

Not analysed

Q35. Once information has been used what happens to it?

Not analysed.

Section D: Manager Demographics

Q1. Gender

Interviewee gender	No.
Male	33
Female	0
Total	33

Q2. What is your position within the company at the present time?

Interviewee position	No.
MD / GM / Mgr	18
Director	4
Senior Mgr	11
Total	33

Q3. In what year were you born?

Interviewee age	No.
20 – 30	3
31 – 40	8
41 – 50	12
51 – 60	8
60 +	2
Total	33

Q4. Are you an owner who manages the company, or are you employed to manage the company?

Interviewee status	No.
Owner/Manager	18
Employed as manager	15
Total	33

Q5. What proportion of your time do you spend on the shop floor?

Average proportion of time on shop floor
22.42%

Q6. What is your highest educational qualification?

Educational qualification	No.
Post graduate	2
Degree	14
Trade	12
Secondary	5
Total	33

Q7. Looking at showcard W which information sources do you use for each of these product development activities?

	Initial screening	Preliminary market assessment	Preliminary technical assessment	Detailed market research	Financial feasibility study
Personal experience	28	20	21	13	23
Customers	26	29	10	23	6
Suppliers	11	7	14	10	4
Trade associations	7	5	6	6	2
Government agencies	4	4	3	1	1
Libraries	6	3	8	5	1
Media	4	4	3	1	0
Trade journals	8	8	5	3	1
Trade shows	6	7	5	7	2
Business consultants	1	4	9	12	6
Family and friends	5	6	2	2	0
Company staff	20	14	17	7	14
Other companies	14	13	8	10	5
Patent information	8	3	8	4	0
Information brokers	1	1	2	4	0
On-line Sources	2	4	3	5	1
In-house Sources	16	12	18	8	17

Q7. Looking at showcard W which information sources do you use for each of these product development activities?

	Prototype design	In-house testing	Consumer testing	Detailed design	Trial production	Test market
Personal experience	27	22	12	24	16	12
Customers	14	8	22	11	10	27
Suppliers	10	5	6	10	10	7
Trade associations	2	1	3	5	1	2
Government agencies	0	1	3	2	1	1
Libraries	1	1	0	4	1	0
Media	1	0	1	2	0	3
Trade journals	3	0	0	2	1	2
Trade shows	4	0	4	5	1	4
Business consultants	4	2	4	8	3	4
Family and Friends	3	5	7	1	2	6
Company staff	18	22	14	22	24	13
Other companies	9	2	1	7	1	3
Patent information	2	1	0	8	1	0
Information brokers	1	0	0	2	0	1
On-line sources	2	0	1	2	2	1
In-house Sources	16	14	6	17	16	6

Q7. Looking at showcard W which information sources do you use for each of these product development activities?

	Pre-launch business analysis	Production start-up	Market launch
Personal experience	16	16	12
Customers	12	6	23
Suppliers	4	7	7
Trade associations	2	2	8
Government agencies	2	0	1
Libraries	1	0	1
Media	2	0	9
Trade journals	3	0	9
Trade shows	4	0	13
Business consultants	5	1	7
Family and Friends	2	0	4
Company staff	11	24	13
Other companies	4	1	6
Patent information	0	0	0
Information brokers	1	0	3
On-line sources	1	1	2
In-house sources	10	15	7