A STUDY OF THE PRODUCT DEVELOPMENT PRACTICES OF SMALL MANUFACTURING COMPANIES IN NEW ZEALAND

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ABSTRACT

Companies' existing products are increasingly coming under pressure through competitive forces, changing market demands and rapidly advancing technologies. A continual stream of new products is required to maintain a competitive portfolio of products in the marketplace. Therefore, more and more attention is being focused on the systems that companies use to develop their new products. These systems involve the discipline of Product Development.

The aims of this study were to investigate the practice of Product Development in small companies in New Zealand and to study the effects of the New Zealand environment on the attitudes and undertaking of Product Development. Specifically, the objectives of the study were to investigate the Product Development process used and the techniques used for conducting Product Development; compare the New Zealand practice with those obtained from overseas studies; to assess the management, organisation and attitudes of managers to Product Development; and to investigate the outcomes of the companies' Product Development efforts.

The small companies in the manufacturing sector were the subject of the research and the food, electronics, and light engineering industries were selected to represent Product Development in this sector and to provide inter-industry comparisons. Eight-four companies responded to a questionnaire sent out nationally in April 1993.

The Product Development process used by the small companies was truncated, utilising on average 8 of the 13 prescribed stages of the process. This was due in part to a concentration on the physical development of the product, leading to the omission of vital stages such as marketing research and financial evaluations. Use of a more complete Product Development process was related to product and company success.

The stages in the Product Development process used by these small manufacturing companies were

Idea Screening
Preliminary Market Assessment
Preliminary Technical Assessment
Prototype Design and Development
In-House Prototype Testing
Customer Prototype Testing
Production Start-Up
Market Launch

The techniques used for conducting Product Development were simple and easy to use, particularly for the more intangible activities, thus providing simple information upon which managers make important development decisions.

In comparison with studies conducted in Canada and Spain, the use of the Product Development process was remarkably similar both in the type of stages undertaken and the number of stages undertaken suggesting there exists a 'base-level' of Product Development knowledge and understanding regardless of company demographics or geographics. The techniques of Product Development as used in New Zealand companies were more aligned to that used in Spanish small companies both in level of use and simplicity. The Canadian companies used fewer techniques but they tended to be more complex.

Company managers were found to play a crucial role in product development within their companies in terms of being actually involved in product development, generating new product ideas, and recognising the appropriate environment for development to occur. In these small companies usually only two people were involved in Product Development, the manager almost always was one of these people. The time awarded to developing new products was typically only five hours per week. Although the managers recognised the importance of Product Development, they had little resources to undertake it effectively.

Finally, the study found that these small companies were producing only moderate results from their Product Development efforts in terms of product success, innovativeness, the number of new products introduced, and overall company growth. Over simplistic Product Development methods and resource constraints were preventing companies from fully capitalising on their potential for innovation.

A more complete Product Development process, utilising techniques that provide and analyse more relevant information, and giving more attention, resources, and control to Product Development could significantly improve these small companies' performance in terms of developing and introducing new products. Overall, greater awareness of Product Development as a total system within the company, and disseminating the practice and benefits of Product Development is needed to effect change in the New Zealand small manufacturing sector.

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1.0 INTRODUCTION

At the heart of all business is the selling of products or services for a profit. Indeed, a company would soon cease to exist if it could not produce products that someone would be willing to purchase. Thus, it follows that one of the most essential of all business activities is the development of products that satisfy the needs, wants, and expectations of customers so that the company generates profits which, to a large degree, guarantees its future. This fundamental business activity is known as **product development** and is the subject of this thesis.

Product Development essentially, is the initialisation, development, testing, and commercialising of new or improved products. Every company, therefore, carries out activities of Product Development to some degree regardless of whether they are in industrial or consumer markets, large or small companies, in California or Dannevirke. Product Development is controlled and implemented with a **process** that is formal, sequential, and systematic. It is this use of a process which is at the heart of effective Product Development. Such activities involve the initial conceiving of the product idea or searching for a new business opportunity, through to the launching of the product onto the market and its subsequent evaluation and improvement. Product Development, by this definition, is therefore not just the activities concerned with building the physical product or prototype, as the layperson may understand it, but involves a much greater number of activities.The development of a new product is a very complex business. The use of a process and a logical program of activities allows the product to be developed accurately, and completely, ensuring that some important detail is not overlooked.

The outcome of effective development is new products and services that are innovative, of high quality, and fulfil the demands and needs of customers. Existing products continually need to be upgraded in today's competitive environment. Increasing competition, the continual development of new technologies and applications, ever more demanding consumers, and shortening product life cycles ensure that companies that want to survive, must introduce new products in the future, which have to be developed now. The role of Product Development is to coordinate development activities, optimise the product's market potential, and reduce the inherent risk of developing new products for the company. Product Development, therefore, should be a central factor in corporate strategy.

The extent to which the process of Product Development is undertaken and the activities used within development provide an identifiable means to assess a company's level of understanding and practice of Product Development. Also greatly affecting the practice of Product Development are the attitudes of management towards the discipline. Thus, the process and the management of Product Development were chosen as the central themes for this study of small companies in New Zealand.

Product Development is central to many of the business issues that are currently being cited as crucial to New Zealand's future economic well-being. Innovation, exporting, and technology transfer are all activities that have the development of successful products or services as their central theme. Innovation in particular, has been heralded as a crucial means of improving export performance and generating the benefits that this brings. Product Development is a central theme of innovation; innovation being defined as the process used to take the initial conception of a new idea (utilising creativity), through development of a prototype (an invention), to a successful product in the marketplace (an innovation). Product Development with its unique management, a formal step-wise process, and specific techniques is a means to actually create new products, and to effect innovation.

Although Product Development as a specific discipline has received little attention in this country, there has been substantial research investigating the subject overseas, particularly in the United States where academics and industry have identified the importance of Product Development to corporate success. It was also the aim of the present study to apply this advanced theory in the New Zealand setting to establish the state of Product Development within our businesses. In order to achieve this, it was first necessary to establish where our companies were placed relative to the overseas academic theory and industrial practice. This could identify any major deficiencies in New Zealand Product Development practice and allow for recommendations to be constructed to address these deficiencies.

In order to apply overseas Product Development theory to the local environment, relevant overseas literature on small companies was evaluated and similar New Zealand research was undertaken to determine the possible effects of the local environment on the undertaking of Product Development in small New Zealand manufacturing companies.

In conclusion, this research was undertaken on an exploratory basis to investigate the practice of Product Development in small manufacturing businesses in New Zealand. The specific aims of the research were to:

- survey selected New Zealand companies to gather relevant information on local Product Development practice.

- assess the nature and the complexity of the **Product Development process used**, and the nature of the individual **techniques** used within the process.

- **compare** the surveyed New Zealand practice with that which had been reported **overseas**.

- assess **management's attitudes** towards Product Development and the environment or organisation they have in place for the Product Development function.

- determine the **outcomes of these companies' Product Development efforts** and relate these to the practices of Product Development.

- determine any differences in Product Development practices among **different manufacturing sectors** and in Product Development practices between manufactured products and service products.

- make conclusions as to the practice of Product Development in New Zealand and offer recommendations that might improve its practice and outcomes.

2.0 PRODUCT DEVELOPMENT SYSTEMS

This section introduces how the discipline of Product Development has evolved and the central issues that are relevant to this research. It includes a review of the literature investigating the evolution of a process for Product Development, the techniques used within Product Development, management issues relating to Product Development, and the study of reported success factors.

2.1 The Process of Product Development

Prior to the recognition of Product Development as a unique discipline, products were, of course, being successfully developed and introduced. The methods by which these products were developed, however, had seldom been the subject of research. Companies had to apply some method to develop these products, a process known only to each individual company.

It was not until the late 1960's that Booz-Allen and Hamilton (1968) undertook the first significant investigation into Product Development. In order to gain some insight into what actually occurred in the development of new products and how it was managed, they studied the practices and management that occurred in development projects from a very large sample of companies. They discovered that the most successful companies were those that used a recognised process in the development of their products and that these companies used it in a systematic manner, completing set stages in a structured way. The more successful companies also placed more emphasis on Product Development and backed this up with more resources.

Booz-Allen and Hamilton (1968) identified and generalised the development processes used by successful companies and they provided Exhibit 1 as a common basis for successful Product Development. This process, although quite primitive at this initial stage, provided the first, and probably the most crucial, insight into Product Development.

Exhibit 1 Booz-Allen and Hamilton's (1968) Product Development Process

Exploration

Screening

Product Development

Testing

Commercialisation

Launch

Booz-Allen and Hamilton (1968) commented that the identification of a Product Development process gave management a 'game plan' that assisted them in managing and organising the development of new products. Firstly, it provided management with specific activities that should be performed in order to correctly or optimally develop the product and to perform them in a set order. This greatly increased the chance of developing a successful product because stages were performed, not overlooked or forgotten, and the evaluation of certain areas within development reduced the risk of introducing a poor or unwanted product (Cooper and Kleinschmidt, 1986).

Secondly, having a procedure to follow over the duration of a development project could greatly assist management in planning. If one knows what is going to take place in the future then one can more accurately allocate resources and finances. The defining of the various stages into broad categories detailed the approximate activities that companies followed within development. Using these broad terms, the development process was adaptable and applicable to all development projects.

Thus, the identification of a process to develop new products by Booz-Allen and Hamilton was a significant stage in the development of the discipline. Although the process they put forward was rather superficial and lacked in specific content, it provided the first description that qualified the events that took place in the development of new products.

A further stage was added to the Product Development process by Booz-Allen and Hamilton in the early eighties (1982) after they conducted their second extensive study into new Product Development practice. The stage of New Product Strategy was added to the development process as a reflection of the increased recognition of having corporate strategy guiding the new product strategy and for having a strategic approach to the development and introduction of new products. This reflected the general awareness of the importance of the inclusion of strategy into management and business practice. Their second study suggested that companies had started to spend a greater proportion of money on the earlier 'homework' stages of the process and that Product Development programs had become more efficient, ie. less time and resources wasted on developing unsuccessful products.

Earle (1971) provided the next insight into the Product Development process when she outlined a systematic development process constructed through experience in large European companies and some New Zealand companies. This development process, outlined in Exhibit 2, provided a detailed sequence of steps as well as individual activities to be undertaken. In comparison with Cooper's (1983) normative model, Earle's model was advanced both in regards to a multidisciplinary approach and in detail. In comparison, the model proposed by Crawford (1983) appeared to highly favour the marketing aspects of the development process, concentrating on stages of concept generation, concept evaluation, and commercialisation. Similarly, new product planning and strategy was an area stressed by Crawford and is clearly addressed by Earle in this much earlier work. Stage reviews or Go/No-Go decisions were also included in Earle's Product Development process as a means to evaluate the viability of the project at numerous points throughout development..

Exhibit 2 Earle's (1971) Product Development Process

Planning
- define project aims, objectives, constraints
- idea generation

Literature Investigation
- market, technical information research
- screen ideas
- define product concept

Detailed Study of Market, Product, and Process
- consumer survey
- preliminary product tests
- project costings
- evaluate and select final product concepts

Develop Prototype
- laboratory tests
- design specifications
- build prototypes
- packaging, patents, legal considerations
- analyse prototypes

Develop Production Plan
- quality control
- final product specifications
- small production run
- costings

Plan Production and Marketing
- determine pricing and market potential
- advertising and packaging design/storage tests

Organise Launch
- organise advertising/promotion material
- organise equipment/labour/raw materials
- test market

Launch
- train salespeople
- product production
- distribution
- release promotion

It is somewhat surprising that the next significant comment on the Product Development process did not occur until fifteen years after Booz-Allen and Hamilton's (1968) study given that they concluded that a disciplined, step-wise process [ie. what happens in those steps from idea to launch] was so important. Cooper (1983) reviewed the literature on process models and determined that these were either descriptive processes evolved through empirical studies and lacking in effective managerial detail (Booz-Allen and Hamilton, 1968; Myers and Marquis, 1969; Little, 1970; Rothwell, 1972; Utterback et al., 1976), or were specific to particular product groups (Hanan, 1970; Albala, 1975).

Cooper presented his normative model based on recent research findings, an analysis of previous

normative models, and a review of case history Product Development processes. His model contained seven stages, similar in structure to Booz, Allen and Hamilton (1968), with sixteen activities as shown below in Exhibit 3. Cooper's model was very similar to that of Earle (1971) as previously discussed, which tends to add validity as to the ability to recognise and use a systematic Product Development process.

Exhibit 3 Cooper's (1983) Product Development Process

Stage 1 Idea	Idea Generation Idea Screening
Stage 2 Preliminary Assessment	Preliminary Market Assessment Preliminary Technical Assessment
Stage 3 Concept	Concept Identification Concept Development Concept Test
Stage 4 Development	Product Development Marketing Plan
Stage 5 Testing	In-house Prototype Testing Consumer Prototype Testing
Stage 6 Trial	Finalisation of Design Finalisation of Marketing Plan Trial Production Test Market
Stage 7 Launch	Full Production Market Launch

Cooper (1983) offered this model as a normative guide to managers to ensure that many of the critical steps in the process were not overlooked. The benefits of implementing such a systematic process were, he concluded,

- a multi-disciplinary approach integrating marketing, technical, and production,
- the incremental nature of the process progressively refines information and manages risk through evaluations at each stage, and
- provides a marketing orientation.

A study by Feldman and Page (1984) attempted to compare new product theory at the time with what was actually occurring in industry to identify any disparities. They compared the following three principles to the practices of nine large electronic companies.

- an orderly, logical and sequential process,
- strategically-based new product plans, and
- the use of sophisticated management techniques, coupled with the Booz-Allen and Hamilton process model,

The results of their study suggested, "that companies do not link their new product activities with the corporate strategic plans, that there is little use of sophisticated managerial or analytical techniques such as conjoint analysis, concept testing, and financial analyses, and that companies' new product planning processes were characterised by a relatively high degree of informality that bore little correspondence to any normative model". Feldman and Page blamed this poor result on firstly, the complexity of the Product Development process, involving intangible concepts, varying disciplines, creativity, and secondly, managerial shortcomings. They proposed that having a strategic orientation in the new product planning process, ordering the process by making it more uniform and systematic, and increasing the amount of marketing research would make this activity more successful.

This comparison of theory with industry practice was the first demonstration of the gap between academic suggestion of what should ideally occur in Product Development and what industry actually does.

Moore (1987) conducted a similar study on 25 large industrial marketing companies and found that most of the companies employed a relatively systematic, but again informal, process for developing new products. Informal control was in evidence throughout the process and did not become more formal in the later stages as suggested by previous research (Johne, 1984). A number of less sophisticated, small scale qualitative market research methods were used by the companies and Moore (1987) suggested that these may be more appropriate than the more sophisticated methods analysed by Feldman and Page (1984).

A detailed study into the actual working of Product Development within the company was conducted by Cooper and Kleinschmidt (1986). In their comprehensive study they used a 13 stage development process generated from both normative and empirically based descriptions to test the actual practice in 203 projects. Their 13 stage model consisted of:

Exhibit 4 Cooper & Kleinschmidt's (1986) Product Development Process

1. **Initial Screening**
2. **Preliminary Market Assessment**
3. **Preliminary Technical Assessment**
4. **Detailed Market Study/Market Research**
5. **Business/Financial Analysis**
6. **Product Development**
7. **In-house Product Testing**
8. **Customer Tests of Product**
9. **Test Market/Trial Sell**
10. **Trial Production**
11. **Pre-commercialisation Business Analysis**
12. **Production Start-up**
13. **Market Launch**

Each development stage was then probed in more depth to also determine the type and nature of the techniques that were employed in each stage. The results suggested that 'what the literature prescribes and what most firms do are miles apart when it comes to the new product process'. The results detail that commonly prescribed activities, such as a market research study, a trial sell, a trial production and a pre-commercialisation business analysis were undertaken in less than half of the projects studied. In the majority of the projects, less than 9 of the 13 stages were carried out - resulting in a limited new product process. The new product process was deficient in many companies, even if management had a systematic process in place, many activities were omitted or superficially undertaken. Product improvements or product line extension development would suggest a shortened process but this study looked only at new products.

They also determined that the inclusion of several key Product Development stages was related to the outcome of the projects. The results indicated that success was determined by undertaking

detailed market study/market research, initial screening, and preliminary market assessment. Product success was also related to the completeness of, or more stages used within, the Product Development process. In conclusion, Cooper and Kleinschmidt, stated that "**project success is closely linked to what activities are carried out** in the Product Development process, **how well they are executed**, and the **completeness of the process**". These factors are generally reliant on the people working on the project and not on external environmental factors. Hence, this study demonstrated the importance of the Product Development process and certain stages to the success of products. They recommended that:

- Having a Product Development process model and adhering to it in a disciplined manner will prevent the omission of necessary activities,
- More time, effort, and resources be devoted to the new Product Development process given its importance to the firm, and
- More focus is placed on certain key activities to ensure they are carried out well. These activities relate to the up-front stages of the process.

Cooper and Kleinschmidt's (1986) study was replicated in Spain by Sanchez and Elola (1991). Fifty-six industrial firms were interviewed in regard to the above mentioned activities. Their results were similar to those found by Cooper and Kleinschmidt and followed the same general pattern. A relatively systematic but informal process was once again in evidence. Furthermore, they found that most of the new products were of the incremental innovation type, that on average 6 new products were launched per year, and that most new ideas came from customer requests and the R&D department. They concluded that relevant management training was practically non-existent in business schools leading to a lack of competence in managing the Product Development process, that there was a need to improve inter- and intra-company information systems, that the employment of a person as an innovation advisor was important to promote radical innovation, and that the predominance of technical activities over marketing promoted a 'technology push' rather than a 'market pull' orientation for new products.

A similar study to that of Cooper & Kleinschmidt (1986) was undertaken by Hise et al. (1989) but instead of investigating the stages that made up the complete Product Development process, they investigated the activities involved in the design stages of a project. Through an evaluation of the literature, they concluded that although previous studies had found that the design process makes up approximately one third of the time spent in Product Development, research studies

investigating the Product Development process have ignored the nature and impact of the technical design activities.

Hise et al. (1989) asked 195 manufacturers of industrial products which of the following stages they used in their design process and how successful the resulting product was. The design process was made up of:

Exhibit 5 Hise et al.'s (1989) Product Design Process

Rough Drawings
Detailed Drawings
Crude Working Models
Testing Crude Working Models
Prototype Designs
Testing Prototype Performance
Final Modifications

The two main design activities used were 'prototype designs' and 'testing prototype performance' with under half of the companies making and testing crude working models. The undertaking of rough drawings and detailed drawings were significantly related to product success, as was a more complete product design effort. In conclusion, the authors suggested that even in the pressures of faster development times, more activities should be undertaken to ensure that problems such as poor design, malfunctioning, product liability suits, and potentially higher production costs are reduced. The recommendations for a more complete design process is analogous to Cooper and Kleinschmidt's (1986) recommendation for the use of a more complete Product Development process. The similarity of these results tend to validate the suggestion that conducting more activities in the development process is beneficial to product success regardless of orientation or discipline.

The new Product Development processes of 200 'Fortune 500' companies were investigated by Mahajan and Wind (1992). They used a ten-stage process model that was highly slanted towards a marketing bias. They determined that the most used, and most important, stages in the company's Product Development process were 'financial business analysis' and the 'development of the prototype'. The stage of 'detailed market study', 'pre-market volume forecasting using a

prototype', and a 'market test' were used least frequently, supporting Cooper and Kleinschmidt's (1986) work. In their investigation of the techniques used within these stages they concluded that the use of new product techniques and especially analytical techniques was not widespread. Focus groups were used over a number of Product Development stages and the Product Development function was most frequently housed within the marketing department (27% of companies).

In conclusion, Mahajan and Wind (1992) stated that most companies typically did not use an extensive Product Development process and the earlier stages of the process could benefit from more formal and quantitative approaches. Finally, they suggested that new product models need to be simplified to attract companies to use them, and that case studies demonstrating the actual use and benefits of the implementation of a Product Development process and techniques will assist adoption.

The Product Development and Management Association in America sponsored a 'Best Practice Study' to investigate the current Product Development practices and to provide longitudinal research by comparing this 1993 study to the previous Booz-Allen and Hamilton studies of 1968 and 1982. The study conducted by Page (1993) detailed many aspects of the operation and importance of Product Development to companies. Relevant issues reported by Page included:

- on average the companies introduced 9 new products per year (the median number of the 189 companies being 4 per year)
- 55% of the companies had a well-defined, structured process that was followed, but which had only been in place on average for 5 years
- 76% of businesses used multidiscipline teams as an organisational structure for Product Development
- 56% of R&D time, 34% of engineering time, and 28% of marketing time was devoted to working on new products
- it took 11 product ideas to produce 1 successful product on the market (c.f. 7 from Booz-Allen & Hamilton (1982))
- the average rate of success of introduced products was 58%
- the main obstacles to Product Development were found to be
    - resources (financial, people, other) (32%)
    - implementing activities within the Product Development process (29%)
    - top management support (25%).

The model used by Page to investigate the Product Development process, its usage, and the time spent on each stage are shown in Exhibit 6.

Exhibit 6 Page's (1993) Product Development Process

Activity	Companies Using (%)	Time Spent (Months)
Concept Search	89.9	3.51
Brainstorming, product design discussions, and new product opportunities		
Concept Screening	76.2	2.96
Scoring concepts against criteria, eliminating poor concepts		
Concept Testing	80.4	3.63
Preliminary market research to determine needs, niches, and attractiveness		
Business Analysis	89.4	2.58
Evaluation in financial terms of proposition		
Product Development	98.9	14.37
Technical work to convert concept into a working prototype		
Product Use, Field, and Market Tests	86.8	6.04
Offering product to selected group of customers to determine its suitability and marketability		
Commercialisation	96.3	6.46
Launching the new product into full-scale production and sales		
Other Process Activities	20.1	8.59
Including regulatory approval/patent filing		

Page compared the main problems cited in the two previous Booz-Allen and Hamilton studies with those determined from his study. The problems that companies experienced in attempting Product Development were organisational problems in 1968, lack of attention to Product Development in 1982, and lack of resources in 1993. Page suggested that resource problems were probably reflecting the highly competitive and poor economic conditions existing in North America at the time of this most recent study.

Page concluded that companies in the 1980's had to run harder to stay in place because of a more difficult external environment, due to accelerating pace of new product introductions and more competitive markets, coupled with insufficient resources in the internal environment. He concluded that the pressures for new products would undoubtably intensify in the 1990's and companies would have to improve their Product Development processes.

The use and appropriateness of Product Development processes were discussed by Wind and Mahajan (1988). They made several observations as to why Product Development was not performing:

- A large number of companies conduct few Product Development activities.
- Companies are increasingly relying on strategic alliances for new products or technologies rather than through internal development.
- Even among those firms that have a systematic process in place, there are many gaps and deficiencies in their processes.

They suggested that the outcome of the companies' Product Development processes could be improved by:

- Ensuring the Product Development activity is multidisciplined incorporating marketing, R&D, manufacturing, finance and not solely the realm of R&D.
- Moving away from a Product Development effort focused on low-risk options, expected short-term results and nonsynergistic projects.
- Not viewing the process as a rigid sequence of steps (hurdles) once adopting a textbook process.
- Tailoring market research to provide more relevant information such as generating ideas, and evaluating concepts under dynamic market conditions.

Most of their suggestions, however, involved influencing the manner in which Product Development is undertaken, ie. managerial and organisational issues, rather than problems specifically related to the nature of the Product Development process.

In conclusion, the development process used to develop new products has received moderate attention in the literature. Although many people have put forward models of ideal or theoretical development processes, empirical research into what companies are actually doing shows a considerable void in practice from that prescribed in theory. Determining if this void between industry practice and the theory in the literature was also present in New Zealand was the major aim of this present research study.

The Product Development processes used by companies has been determined to play a fundamental role in development efforts. Important Product Development process issues to study in New Zealand were:

- the Product Development process framework suggested by many authors and researchers, although differing in terminology and emphasis, shows a similar logical progression as the product idea progresses through concept, prototype, to commercialisation.
- the Product Development process as used by companies is typically incomplete, informal, and omits many important stages.
- a complete development process and conducting certain key stages influences product success
- the Product Development process is an organising and management tool and helps to reduce the risk inherent within the function.
- companies should look to implement a more structured, systematic, and formal Product Development process

2.2 Techniques Used Within the Product Development Process

The Product Development process used by a company provides it with a structured game plan and method by which to plan and control a development project. The extent or completeness of a Product Development process depicts a company's recognition of the need for conducting Product Development but it is the techniques actually used to conduct Product Development that depict the company's level of sophistication in their Product Development efforts. Although this research concentrated predominantly on the process used for Product Development, a review of the techniques typically used within Product Development was also necessary.

Few studies have investigated the actual techniques used throughout the Product Development process. The exception has been the research conducted by Cooper and Kleinschmidt (1986) and to a less extent that of Feldman and Page (1984) and Mahajan and Wind (1992). All of these studies suggested that the techniques used for Product Development in industry were more primitive than those described in the literature and that few sophisticated analytical or management techniques were used. These sophisticated techniques, such as conjoint analysis, Multi Dimensional Scaling, Internal Rate of Return, have been developed to provide more detailed information for management to make decisions. The Product Development process is largely an information collection process and it appears that companies are using simple and easy to use techniques to gather information. Thus management may not be receiving appropriate, correct or timely information on which to base their Product Development decisions.

Exhibit 7 shows a selection of techniques used in Product Development process. It shows both the techniques suggested by academics and those used by industry. Many more techniques exist and are practices; those lists here are specifically those cited in texts or reported from empirical studies.

Using the Product Development process (Cooper and Kleinschmidt's (1986)) the techniques reported in the literature have been included for each stage. Earle (1971) and Cooper and Kleinschmidt (1986) provided a detailed listing of the techniques used and showed the most multifunctional approach. Exhibit 7 demonstrates the multidisciplinary nature of Product Development involving, throughout the development sequence, the techniques of many different functional areas such as marketing, design, production, finance.

Exhibit 7 Techniques Used in Product Development

Idea Generation
focus groups, brainstorming, attribute analysis, gap analysis, lateral thinking, employees suggestions*, managers ideas*, observations, customer requests*

Initial Screening
scoring methods using criteria and weightings, group evaluation*, informally by one person

Preliminary Market Assessment
analysis of the marketplace including information on competitors, market shares, market size, consumers, customers*, product positioning

Preliminary Technical Assessment
analyse information on government regulations, patents, capability analysis*, engineers assessment*, drawings* or specifications

Detailed Market Research
concept testing, conjoint analysis, a study of competitive products and prices*

Business/Financial Analysis
costs and sales forecasts*, discounted cash flows*, return-on-investment*, payback period, profit

Prototype Development
physical construction of the product

Prototype Testing - In House
product use tests*, field tests, technical tests, expert evaluations

Prototype Testing - Customer
repeat of concept test, customer evaluations*, structured consumer evaluation testing

Trial Production
pilot plant production, small run*

Test Market
test market, sales tests, roll-out assessment, controlled conditions testing, sample given to customers to try*

Pre-Commercialisation Business Analysis
sales forecasting*, Net Present Value, payback, rates of return, financial analysis*, a cost review*

Production Start-Up
purchasing of new equipment*, commissioning*, plant trials

Market Launch
organise distribution/personal selling, advertising*, marketing plans, trade show*, trade literature prepared*

* Those techniques found from empirical research to be significantly used by companies

By comparing the techniques used in industry by those recommended by academics, it can be seen that there is a difference in the level of sophistication or complexity of the techniques. It has been suggested that techniques used for Product Development should be analytical in nature to ensure accurate information for decision making. Industry, on the other hand, often uses simplistic methods to collect and evaluate information and predict the outcome of the product in the market.

2.3 Management Issues of Product Development

Although having a systematic Product Development process has been demonstrated as a crucial requirement for ensuring product success, such a process and many other company characteristics that determine the extent and nature of Product Development, are largely reliant on the attitudes and support of top management. The attitudes of management influence the Product Development process used, the practices undertaken, and the environment and resources offered to the Product Development function within companies.

Midgley (1977) summarised the importance of many of these issues;

> "Each new product must be an innovation, perceived by the consumers as a distinct improvement over existing solutions to their problems, and as performing according to their expectations of it. The only way for the organisation to meet such objectives is by assigning new Product Development a central role in the company, and one supported by adequate and totally committed resources. Furthermore, the approach cannot be piecemeal, according to the exigencies of the day, but must be continuous, coordinated and systematic. The organisation needs to evolve a well-defined new Product Development system, supported and maintained by specialists, but involving all departments of the company."

Similarly, Johne and Snelson (1990) commenting on the role of management in Product Development suggested that top management must determine appropriate development strategies, construct an effective organisational structure, encourage and communicate vision, be proactive in Product Development, and create and nurture cross-functional market-led teams.

Much of the theory specifically for the management of Product Development has been concentrated in several key texts. These have largely concentrated on the issues of management support, organisation, strategy and cross-functional integration for Product Development.

Management Support

Booz-Allen and Hamilton (1968) identified various management factors that influenced the success of Product Development from their study. The first of these was that Product Development was substantially more successful when top management was directly involved in the process. This was because Product Development was often a new concept for a company and it had to be fostered by management to ensure its effective operation. Similarly, management should be directly involved with the Product Development function due to the importance of ensuring that the correct products are developed for the future of the company and that the products are developed correctly.

Booz-Allen and Hamilton (1982) suggested that improving Product Development performance would depend upon;

- a well-defined new product strategy
- a consistent management commitment, and
- conducted in a company environment conducive to achieving company-specific new product and corporate objectives.

They concluded that being successful at Product Development was not a simple process and that new products management is a delicate and subtle process, not subject to broad generalisations or universal guidelines. The difference between successful and unsuccessful companies was related to operating philosophy, organisational structures, extent of experience with new product introductions and management styles.

Establishing an environment conducive to Product Development and top management support in fostering Product Development efforts has been commented on as an essential prerequisite to the undertaking of Product Development (Andrews, 1975; Twiss, 1980; Crawford, 1983). Andreasen and Hein (1987) stated that Product Development is revolution in terms of the traditional nature of most companies and as such must be fostered by top management. This was also supported by Twiss (1980) who suggested the Product Development management is a complicated task,

'controlling an expensive activity while at the same time providing an environment within which individual creativity and entrepreneurial drive can flourish'.

Johne and Snelson (1990) investigated many management issues of Product Development from their study investigating management practices in leading large British and American manufacturir firms. The four management factors that were common to firms that were more successful in Product Development were:

- top management lent appropriate support to Product Development which had been agreed as serving the needs of the business.
- individuals from all levels were keen to join Product Development teams because these provided a vehicle not only for corporate growth but also for personal growth.
- Product Development was first and foremost market-based, not asset-based or capacity-based.
- the organisation differentiated quite deliberately between the management of produc improvements and the management of new Product Development.

Organisation

The most effective organisational structure in which to conduct and control Product Development efforts is a management theme that has also received much attention. All texts on the subject of Product Development include a section devoted to the different types of organisational structures traditionally used for Product Development. Andrews (1975), in an early comment suggested that Product Development should be a specialised function separate from normal company operations and influences such as company bureaucracy. A separate Product Development department and new venture teams were recommended by Andrews. Due to problems of integrating different functions working in Product Development, Crawford (1983) suggested the use of a matrix organisation where a project is conducted in a multifunctional development team. The use of multidisciplined Product Development teams has remained the most cited organisational structure for effectively conducting development and the research into this area has largely centred around the interaction of different disciplines, mainly marketing and R&D (Gupta et al., 1985; Souder, 1988, 1990) and the management of teams (Barczak and Wilemon, 1989; Thamhain, 1990).

Although a multidisciplinary approach to Product Development and its management has been called for, the integration of all functions and aspects involved in Product Development has received little attention. Crawford (1983) stated that the texts published prior to his work, of which there were 17, failed to take an overall view of the multi-disciplined nature of Product Development management. Andreasen and Hein (1987) made integration the main theme of their book and suggested that the integration of the main functions of production, design, and marketing are crucial for successful Product Development. Exposing the R&D technologist to the ultimate user of the product and to market forces was also a necessary practice suggested by Twiss (1980) as well as marketing to be integrated throughout the process.

Strategy

The importance of having a strategy in place to guide the Product Development function and projects has been stated by numerous authors (Crawford (1983), Alder et al.(1989), and Cooper and Kleinschmidt (1991)). The appreciation of corporate strategy in forming product strategies ensures that the new products developed are compatible with the future direction of the company. Similarly, a strategic approach to Product development is necessary to match company capabilities to the future market and technological positioning of the new product to ensure the resources and commitment applied to the product will result in the greatest potential business proposition. The use by companies of an 'Innovation Charter' was proposed by Crawford (1983) to provide strategic creative direction and to encourage innovative endeavours and attitudes. Cooper and Kleinschimdt (1991) have linked the innovation strategy for new products with the outcome of the product, suggesting that product strategies that target known markets and technologies or those targeting new markets and technologies, ie., low and high innovative products, have higher degrees of success than those using moderate innovation strategies.

This brief review of the management issues of Product Development has identified the key role management plays in dictating the ability of the Product Development function to perform and to produce successful results. The Product Development function relies on management to:

- foster an otherwise unknown and non-traditional activity
- provide adequate resources for development
- encourage a creative environment
- integrate corporate strategy with the new product strategy

- establish the right organisational structure for conducting Product Development and to encourage cross-functional integration

One could assume that management understanding and support is a prerequisite for effective Product Development performance. The attitudes of management towards Product Development and their agreement with the above issues would be necessary to measure in attempting to gauge New Zealand companies approach to the Product Development function.

2.4 Success Factors in Product Development

A major area of research in Product Development has been the investigation of success/failure factors. Cooper and Kleinschmidt (1987) stated that gaining an understanding of the new product success factors is important in providing guidelines for the screening of new project proposals and leads to insights into the way the new product project should be managed.

Measures of company, product, or project success have been many and varied. They have ranged from Cooper & Kleinschmidt's (1987) extensive 10 criteria analyses to Link's (1987) manager's self assessment of 'clear cut success'. Pavia (1990) discussed the issues and methods of measuring success and concluded that asking managers for a subjective evaluation of the product success relative to the company's internal expectations and to the competitors was a satisfactory method and one that correlated well with objective criteria. Most measures of success have involved some financial assessment.

Johne and Snelson (1988) in a review of the success/failure literature identified 96 research papers. Reasons for the prolific number of studies in this area arose from the wide variety of types of companies and industries studied as well as different success/failure criteria definitions, resulting in success factors that are not comparable across studies.

The early studies focused on the factors that either made a product a success or a failure (Myers and Marquis, 1969; Cooper, 1975; Roberts and Burke, 1976; Calontone and Cooper, 1979). The studies then moved on to research paired comparisons of successful and unsuccessful new product projects to determine the differences that occurred between the two (Rothwell, 1972; Cooper, 1979a, 1979b; Calontone and Cooper, 1981). These types of studies have been replicated in various other countries including Australia (Link, 1987).

Numerous other studies of major merit have been conducted to date. These include work by Rothwell (1972) and Cooper (1983). The results of these numerous studies were large numbers of lists that contained a large number of varying success factors as shown in the following examples.

Twiss summarised several research efforts on factors influencing a project's outcome and listed the following critical success factors;

- a market orientation
- relevance to the organisation's corporate objectives
- an effective project selection and evaluation system
- effective project management and control
- a source of creative ideas
- an organisation receptive to innovation
- commitment by one or a few individuals.

Johne and Snelson (1990) found that high achieving firms:

- have an explicit Product Development strategy
- pursue a proactive competitive strategy
- explore a wide range of Product Development options
- have formal product planning procedures
- have loose-tight methods for managing Product Development but allow team workers considerable autonomy
- use a business-centred organisational structure rather than a functionally based one.

Because the results of these individual studies were inconsistent, an attempt to conclude the discussion of what makes a product a success or failure, was made by Cooper and Kleinschmidt (1987) who reviewed the literature and proposed a conceptual model of new product success and failure. From this model, ten hypotheses were derived and then tested against the outcomes of 203 project case histories. They found that eight of their ten hypotheses were significantly related to new product success. These were:

- product advantage
- proficiency of pre-development activities
- the use of protocol in Product Development
- proficiency of technological activities
- proficiency of market-related activities
- technology synergy
- market potential
- marketing synergy.

These results have implications for management of the Product Development process. The first of these is that the items that made up product advantage, ie. unique benefits to the customer, product quality, reduced customers' costs, product innovativeness, product superiority in the eyes of the customer, and solution to a customer's problem, should be top priority questions in a project screening checklist; and product advantage should be the number one objective for the Product Development process. Secondly, the most critical steps in the Product Development process are those that take place before prototype development takes place. Management, therefore, must devote the necessary resources to these up-front activities to ensure they are carried out well. Thirdly, the results suggested that the way that the Product Development process is managed and executed, the activities that people undertake and how well they do them from idea to launch, largely decide project outcomes.

While studies on success factors have been the major area of research in Product Development, there appears to be little consensus from these studies. This is because these studies have been very study-specific. The utility for success factor studies has been questioned mainly due to the inconclusive nature of each success/failure study. As Cooper (1986) stated,

> "In short, these success factors are left fairly general: they are not translated into the details of what managers and new product project teams should do... Could it be that the majority of new product success and failure studies have overlooked the obvious?.. For example, few of the success/failure studies have looked at what actually happens during a new product project; fewer still have investigated the strengths and weaknesses of the activities that comprise the new product process and the impact that their activities have on projects' outcomes. If what happens during the new product process itself - the action details - is key to success, then a clear need exists to examine more closely those actions or activities that

make up the new product process."

Two studies on success factors in the food industry appear to be the only research conducted specifically into Product Development in New Zealand. West (1980), found through factor analysis that success at Product Development was determined by:

* innovative and technological company orientation
* supportive company culture
* consideration for the customer
* security for development, and
* well-rounded company marketing.

The company managers she interviewed also cited good consumer research and a unique product as important factors in success.

Putt (1993), carried out a similar study to West (1980) except his research investigated barriers to innovation in the food industry. He determined that poor attitudes, culture, and managers' lack of knowledge of Product Development were the main problems effecting the operation of Product Development in the internal environment of the company. External factors restricting the development of new products in the food industry were low industry profitability, small export markets, and lack of R&D incentives.

In review, the study of success factors has occupied a large segment of research into Product Development as people have attempted to capture and understand the conditions or actions that will lead to product success. These studies have largely been inconclusive. A complete Product Development process and a marketing orientation have been related to product success across studies whereas company demographics have not been found to impact on success.

2.5 Discussion of the Product Development System

In summary, the review of the literature suggested that Product Development has several fundamental governing themes. These themes can be used in an attempt to assess a company's understanding and practice of Product Development by measuring the following four variables:

- the completeness of the Product Development process and the stages used in developing the product
- the complexity, level of sophistication, and emphasis on functional areas of the techniques used within the stages of the Product Development process
- the attitudes, involvement, and actions of management towards the Product Development function
- the success of the products produced by the Product Development efforts and their relation to company/environmental factors.

Industry has typically demonstrated informal and incomplete Product Development processes omitting many vital stages, and utilising unsophisticated Product Development techniques, and consequently very poor product success rates.

This study aimed to determine if this was true in New Zealand and the above central themes were used to measure and compare what is happening in relation to Product Development within New Zealand small manufacturing companies.

3.0 PRODUCT DEVELOPMENT SYSTEMS IN SMALL COMPANIES

The Product Development literature has largely been oriented towards practices in large companies, typically in north America. The main emphasis of this research was the Product Development systems in small New Zealand companies. The practices and suggestions determined from the previous literature investigation may not be immediately transferrable to industry in New Zealand whose industrial population is both limited in number and predominantly small in size. Therefore, the research on the practice of Product development in small companies was studied and the effects small company characteristics have on the undertaking of Product Development. This section outlines the characteristics of small companies that may impact on the undertaking and management of Product Development and summarises the limited research conducted into this highly specific topic.

3.1 The Small Company Defined

The Bolton Report (1971), defined a small company in terms of three characteristics:

- In economic terms, a small firm is one that has a relatively small share of its market,
- An essential characteristic of a small firm is that it is managed by its owners in a personalised way, and not through the medium of a formalised management structure,
- It is also independent in the sense that it does not form part of a larger enterprise and that the owner-managers are free from outside control in taking their principal decisions.

This definition, although attempting to describe small companies in other than numerical or monetary terms, is impractical to use when conducting research (Curran, 1986). Of the studies conducted into small companies, there has been great variation amongst researchers as to the definition, if any, of a small company. The definition of what constitutes a small company has not been established and this makes comparison of results between studies difficult. Definitions regularly involve levels of employee numbers and sales figures or where they are not specified are labelled such as 'very small' and 'small & medium'. Similarly, the definition of what constitutes a small company varies across countries, from 1000 employees in America (Ettlie and Rubenstein, 1987), to 50 employees in Australia (de Souza, 1991). The international definition of a small company has been suggested by the OECD to be 500 or fewer employees (OECD, 1982).

This research adopted the definition used by Devlin and Le Heron (1977) and Bollard (1988) where a manufacturing business is determined in New Zealand to be small if it has 50 or fewer employees. Although the use of selected employee numbers is acknowledged to be a superficial judgement, it aids in the quick selection of companies.

Statistics New Zealand (1992/1993) reported that there were 18,000 small manufacturing companies in 1993 in New Zealand and Haines (1991) reported that very small manufacturing enterprises, ie. those under 5 employees, accounted for 62% of all manufacturing enterprises.

3.2 Small Companies and Their Environment

Reviews of the major inventions through history (cited in Rothwell and Zegveld, 1982) have revealed that most were made by lone inventors or very small companies. Indeed, small companies, and their innovative efforts are seen as being the potential for growth in the economy and a major source of new employment; 'the engine of growth in the economy' (Schumpeter, 1936). This occurs through the potential of small companies to create new ideas, or more to the point, to invent. Bollard (1988) stated that while it is fairly clear that small firms carry out a disproportionate amount of invention, their record in innovation has been disputed. He stated that 'small businesses have a poor reputation for management, Product Development and marketing, and these are all crucial in high technology developments'. The following characteristics are discussed in relation to the small company's ability to undertake Product Development and to produce innovations.

3.2.1 Organisation

Fewer staff should result in a more dynamic organisation and culture due to the lesser need for rigid organisational structures, roles, and bureaucracy (OECD, 1982). Flat organisational structures should encourage people to suggest new ideas, allow them greater contact with both the market and their management, and the company as a whole is potentially more integrated. Because they are more flexible, they can innovate freely, make fast decisions, and take more advantage of non-conformist entrepreneurial forces (Bollard, 1988). The speed of internal communication and a fast response has been cited by Rothwell and Zegveld (1982) as being an advantage of the small firm in innovation. Much has been written on the barriers to innovation that occur in large companies (Abend, 1985).

The fact that the manager or director is often personally involved in new Product Development is possibly one of the most significant factors aiding the undertaking of Product Development in the small firm. The manager's lack of managerial skills, however, particularly those relating to effective Product Development, is often the most significant reason for the low level of occurrence of new products and product failure in the small firm.

3.2.2 Resources

Small companies have limited resources available to them; resources in terms of staff, production equipment, finances, talent, and time. This inhibits their ability to attempt new ventures and to expand their operations. This is particularly evident when trying to do Product Development. Often employees cannot be spared to work on new projects, money is not available restricting the purchase of materials or equipment, and perhaps worst of all, lack of knowledge prevents necessary activities and techniques such as market research being carried out. Few staff means that there is often less overall skills contained within the firm and attracting skilled or specialised people becomes a problem. Overall, fewer skills mean that less quality input is available so that optimal development cannot occur. In the small firm, the effects of these deficiencies is often displayed in the poor quality of marketing endeavours and the lack of success of their new products. Rothwell and Zegveld (1982), suggested that one of the major disadvantages of the small firm is the lack of manpower, particularly in qualified engineers and scientists. Lack of available venture capital is also restrictive.

The lack of available staff means that the manager or small business owner must often undertake the roles of manager, accountant, production worker, quality controller, and customer services. Whereas in the large company each of these is a specialist skill supported by other staff, the small business manager is expected to be an expert in all of them (Bollard, 1988). The lack of available resources within the small company often means that they must go outside the company for advice and assistance. Contracting out production, marketing, and design are common occurrences in small companies due to the lack of internal resources.

Because of the lack of resources, small companies are at a disadvantage in gathering and analysing external information. As a result of this information gap, small firms can have the danger of becoming introspective (Rothwell and Zegveld, 1982). Small firms must therefore actively pursue

the collection of outside information relevant to their operations, particularly if in a field of rapid, high technology developments.

The small number of staff results in inherent teamwork qualities, prescribed in the literature for effectively conducting Product Development and stimulating creativity, however, the lack of resources means their innovative endeavours are restricted.

3.2.3 Niche Products and Markets

The smaller company's role in the economy is to identify and fulfil niche markets, both in supplying large companies through sub-contracting and developing products for the consumer market. The flexible nature of the small company organisation, adaptable production processes, and closer contact to the market, means that small companies can identify and satisfy particular and specific needs of customers and are more able to implement new technologies or systems.

Because small companies and their managers are often in frequent and close contact with the market, they have more potential to be aware of customer perceptions, attitudes, and needs. This close involvement should allow the small company greater ability to adapt their products to meet these needs.

3.2.4 Innovation

Bollard (1988) described how, in New Zealand, product research and development in the small company is likely to be carried out in workshops and garages, by talking to people in the trade, by doing research in the local library, or by snooping around competitors. Similarly, in the small firm, the manager will generally supervise generating, screening, and evaluating the feasibility of new ideas, and in many companies, carry them out personally (Hisrich and Peters, 1984). The loose organisational structure allows for greater freedom to be flexible in setting up new structures, undertaking new ventures, and adopting new systems. Indeed, being flexible gives an advantage to small companies in being aware of and pursuing market changes, quickly adapting to meet changing or new needs. Smaller, more flexible production practices are also usual in smaller companies.

Ettlie and Rubenstein (1987) determined that small companies generally are more innovative per employee than large companies and that small companies were just as likely as large to produce radical innovations.

Rothwell and Zegveld (1982) list some of the advantages and disadvantages of small firms in handling innovations. The advantages include;

- being able to keep abreast of often fast moving changes to markets, customer needs, and technologies
- often possess dynamic entrepreneurial management
- greater and more responsive internal communication.

Disadvantages include;

- lack of specialist R&D and marketing staff lowering the level of scientific and market knowledge in the company
- often disadvantaged in collecting external information
- lack management skills and often dominated by an all-powerful autocrat
- finance is difficult to attract, costly and risky.

The above small company innovation factors do not assist innovation in itself but have the potential to assist and stimulate **creativity**, the necessary initialising input to innovation as the free environment permits ideas to be generated and put forward and concepts to be expanded, ie. aiding in the early stages of Product Development where control is not so necessary. However, the lack of resources typically existing in small companies actually inhibits **innovation**, the total process of developing new products, and large companies are therefore more effective at implementing innovation.

3.3 Product Development Practice in Small Companies

The discipline of Product Development has been discussed for some three decades with areas of interest concentrating on the new products process, correlates of success, strategic practice to encourage and facilitate new Product Development, and the effectiveness of alternative organisational designs. As Pavia (1990) indicated, there remains areas that have received little attention and research; one such area being the application of Product Development theories to small companies. Recently, increased attention has been given to the small firm sector but studies of Product Development focused on small firms still remain scarce.

Most previous studies conducted into the small firm have involved high-tech companies, commonly in the industries of electronics, computer hardware, and instrumentation (Maidique and Zirger, 1984; Oakley, 1984; Knight,1986; Abeele & Christiaens, 1986; Rinholm & Boag, 1987; and Scherer & McDonald, 1988). This concentration on the high-tech is due to the large amounts of well publicised and often spectacular innovations that result from these types of companies.

Steiner and Solem (1988), analysed a number of competitive factors influencing the success of 30 small manufacturing companies. They concluded that previous managerial experience in a similar business, the adoption of manufacturing technologies, the availability of technology resources, and the development of a competitive advantage through cost/price or market specialisation, were all related to successful companies as opposed to less successful ones. The development of a competitive advantage through a strategy of competing in small, defined segments of the market with specialised products, and responding to technological changes and customer demands, contributed to defining successful companies.

Senchack (1981), attempted to define some of the characteristics of small manufacturing companies' R&D activities. Approximately half of the companies surveyed conducted R&D. Of those that did not, most were in the fabricated metal or machinery industries who did not do R&D because the managers did not perceive a need for it. This result reflected the subcontracting nature of the companies. This study suggested that there was a direct relationship between firm size and the incidence of R&D (except for very small companies with an exceptionally high incidence of R&D). However, a measure of the intensity of R&D undertaken (measured by the full time equivalent employees engaged in R&D as a percentage of the total employees) was found to vary inversely to firm size. Firms between 0-10 employees had 26.5% of their staff working on R&D

which quickly decreased to 3.5% for 76-150 employees. Although investigated, no significant result was found relating the size of the firms to the type of innovation performed.

Research has also been conducted into various management issues of Product Development in small companies. Boag and Rinholm (1989), investigated the management practices of 33 microelectronic companies in Canada and the USA to (1) identify the methods small companies use to manage new Product Development; (2) identify stages in the development of new products; and (3) examine the relationship between new Product Development systems and performance. They concluded that success at new Product Development was greater for more formalised companies than for companies which were less formalised or which use informal methods. New product success was closely linked to what methods were used (ie. long-range development plans, budgets, policies, screening procedures, and periodic reports) and the extent to which they are formalised. Likewise, many small company managers were using informal, or no methods, and were only partially aware of the implications on performance of these omissions. Success, they determined, was also linked to the completeness of the Product Development process but which in turn was not related to the age of the company, numbers of employees, or R&D employees.

Knight (1986), investigated the characteristics of 124 small high-tech manufacturing firms in Canada in order to assess their innovation activities. He concentrated on the marketing issues involved in developing innovations and as a consequence discovered that most of the company managers were well trained technically, but had poor skills for general management, particularly so for marketing activities such as promotion, distribution, and relating to customers. The need exists, stated Knight, to train these high technology entrepreneurs in general management skills. The lack of overall skills is a limitation of the small company which would be rectified in a large company by team integration from many disciplines.

Pavia (1991), in a more recent study of 118 entrepreneurial high technology firms investigated the early stages of the Product Development process including idea generation, screening and evaluation. In summary, she found that entrepreneurial, high tech firms relied on informal techniques to generate new product ideas, with heavy reliance on input from customers, who often came to the company with a problem. Customer acceptance and market potential were more important screening criteria for the small firms than strict financial hurdles. Pavia suggested that incorporating the annual strategic plan, environmental scanning, and a database of customer suggestions were ways to generate more feasible new product ideas.

Similarly, Peterson (1988), analysed the source of new product ideas in 483 small companies including retailers, service enterprises, manufacturers, and wholesalers. For the 39 small manufacturers, the main sources of ideas were suggestions by employees and management invention and inspiration. An analysis of the main problems in effective new product idea generation were time, inability to judge what products to sell, neglect of new product search, lack of training, and lack of creativity.

Finally, de Souza (1991) studied innovation in 184 mainly small companies in Western Australia in an attempt to determine the organisational factors which influence innovation and the type and level of innovation resulting. From the study which included 31 manufacturing companies, de Souza found that most of the companies tended to experience infrequent and small/incremental innovation with ideas coming mainly from top management. Communication within the companies was good, they had long-term planning orientations, and management reported being committed to innovation, tolerating autonomous behaviour and risk taking by employees, but did not provide resources or rewards for innovative employees. An innovation score was computed, made up of innovation frequency, type, success, importance and impact to the company. This score determined that most companies fell in the mid-point of the innovation continuum revealing a gap between innovation intention and practice suggesting that although the managers were well intentioned towards innovation, they were unschooled at implementing the innovation process.

A factor analysis revealed two factors, the first being an 'innovation facilitating environment' made up of top management commitment, employee autonomy and risk taking, and rewards and resources for innovation. The second factor, 'long-term orientation' was made up of corporate mission and vision and the need to consider more than short-term results. Company demographics, such as size, were not found to impact on innovation. One interesting factor which had a negative loading for innovation score was 'few rules and procedures' which suggests that employees needed a creative environment for stimulating innovation but also needed a form of control to assist and guide their efforts. What is required for innovation in small companies is a need to balance creative freedom with procedures to maintain control and direction.

3.4 Discussion of Product Development Systems in Small Companies

The research review suggested that small companies have both advantages and disadvantages in terms of conducting effective Product Development. These can be summarised as:

- small companies are indeed creative centres with more ideas being generated, and often more staffing and monetary resources being committed to R&D or Product Development relative to larger companies

- small companies have flat organisational structures, informal environments and close involvement of management

- small companies lack resources and skills to fully utilise their creativity and implement innovation

- the development of new products in small companies is generally conducted on an informal basis with little evidence of tight control, with an incomplete Product Development process and with simple methods

- management is involved in Product Development but they typically have poor skills and knowledge of Product Development and how to effectively implement it.

- company demographics do not appear to be impacting on the ability of small companies to produce or new products or the degree of innovation.

Small companies display many Product Development characteristics similar to their larger counterparts in terms of their use of a Product Development process and techniques, and the resulting products but do exhibit greater levels of characteristics that should promote creativity, communication, and integration.

4.0 THE NEW ZEALAND ENVIRONMENT FOR PRODUCT DEVELOPMENT

It was important to consider the relevance and implications of the overseas Product Development studies to New Zealand small companies. The corporate dynamics that occur in overseas economies, particularly that in the USA from where most of the relevant literature has originated, are far removed from that which occur in New Zealand. This section reported on the scarce quantity of research and comment on the manufacturing industry, R&D, and innovation in New Zealand.

4.1 Recent History

The early pioneers in New Zealand found themselves far from any source of industrialisation, namely Europe and the USA, and when new machinery was required or parts broke, the threat of lengthy delays forced people to improvise with what materials were available at the time. The difficulties of isolation and the nature of the land caused the pioneers to solve problems in ingenious ways and with basic materials and skills. This mind-set of improvisation and need for ingenious ways of solving problems has led to the phrase 'Kiwi Ingenuity' and New Zealand industries provide many examples of developing innovative products and processes. Indeed, New Zealand culture as a whole is regarded as being innovative compared to many other countries and races. This phenomenon would then suggest that the individual culture within the economy is conducive to creative endeavours and stimulates new product ideas.

A look at New Zealand's political history and its influence on the economy paints a different picture. For most of the past, New Zealand relied on utilising the abundant natural resources and favourable growing conditions to produce primary food commodities. The excessive reliance on agriculture and horticulture has been at the detriment of other industries. Whereas overseas the largest industries are in manufacturing and engineering, New Zealand's largest industries are in food and fibre processing (Stuart and McCulloch, 1980). This problem was largely created by the lack of foresight by successive governments to encourage other industries and to remove trade barriers that isolated the economy from a changing and more sophisticated world. This has also resulted in the 'tall-poppy syndrome', where successful or divergent people are 'cut down', and also in a general poor work ethic (Inkson et al. (1986)).

Crocombe et al. (1991), in the most in-depth review of the New Zealand economy, pointed out many of the past factors that have caused our current economic problems, including an emphasis on production and structurally uncompetitive commodities, a misaligned and underutilised education system, over-control by an inward-looking Government, an unsophisticated domestic market, aversion to competition, and poor management training. Many of these factors had a detrimental or inhibiting influence on the understanding and undertaking of Product Development. For example, because local companies were such efficient producers of commodities such as meat and butter and this was where the emphasis was placed, these basic products were forced upon the local consumer. The end result was little incentive for the Producer Boards to differentiate their products and little pressure from consumers for more sophisticated products. Thus little Product Development occurred.

It was not until the mid eighties with the introduction of deregulation and the freeing up of the economy by the fourth Labour government that things began to be rectified. The implementation of these changes, however, caused much strife particularly for our uncompetitive manufacturing industry, the effects of which are still in evidence today. The demise of the uncompetitive company and the laying off of thousands of people saw a dramatic increase in the number of self-employed in the economy. Haines (1991), reported that the number of very small enterprises, ie. those employing less than 5 people, increased by over 11,400 between 1987 and 1990. Over this period, the numbers of people employed in very small enterprises increased by 17,000 (7.4%), while those in large companies fell by over 60,000 or almost 5%. The increase in small companies and self-employment should equate to more new product ideas and potentially more innovative efforts.

In the past two years, an upsurge in activity in the manufacturing sector, led by value-added exporting of quality products, has been reported even in the face of global recession. Many New Zealand companies have now become internationally competitive, have trimmed down, have learnt about quality of product, and fulfilling niche demand. Indeed, it would appear that conditions are conducive to encouraging effective Product Development and innovation within local companies.

The perception of, and support provided for, small companies, differs greatly between countries (Burns and Dewhurst, 1990). Previously in New Zealand, entrepreneurs were synonymous with 'speculators' or 'sharks'. Bollard (1988) suggested that they now receive greater support due to the recognition of their role in the economy and greater weight of public support behind them.

In New Zealand to date there has been little encouragement for small business by Government. The establishment of the Development Finance Corporation in the seventies provided a source of venture capital for small companies but this was short lived due to its collapse. More recently, the establishment of the Business Development Boards has once again given small companies an avenue of funding and advice. Still, however, there remains a void in policy and practice targeted towards the small company sector to encourage networking support, Product Development, and innovation.

The level of investment in R&D within a country also provides an indication of the level of Product Development efforts, although much government research is often fundamental research with no immediate commercial implication. Edwards (1992) reported that in 1990/91 the Government's contribution to R&D was $419m or 0.57% of GDP, in comparison with OECD references countries average of 0.73%. Similarly, R&D by the private sector was $224m (0.4% of sales or 0.3% of GDP), in comparison with 2.0% of sales or 1.05% of GDP in OECD countries. This reflects the low level of investment in R&D by New Zealand companies and probably demonstrates low levels of activity in Product Development.

In conclusion, the New Zealand environment in the past has not been conducive to promoting or stimulating Product Development in New Zealand. Recently, however, there has been increased support for small companies, increased sense of competition and the need to export quality products. This would tend to suggest that the undertaking of Product Development in New Zealand companies could be receiving greater attention.

4.2 New Zealand Research

Devlin and Le Heron (1977) studied 2,500 small businesses in New Zealand in order to obtain information on their demographics and activities. The extensive survey revealed that 97% of the companies employed less than 50 employees and 10% were in their first year of operation. General business problems included difficulties in raising working capital, planning for the business, control of debtors and cash flow, and problems attracting and retaining skilled staff. They concluded by saying that 'by comparison with overseas studies, it is apparent the New Zealand sector exhibits not only most of the characteristics, needs and problems of small businesses throughout the world, but is also a larger component of the economy'.

Devlin (1984), evaluated the status of research into the small business sector and discovered that it was very scarce. Studies on innovation in small businesses have been undertaken by Stuart (1979), McCulloch (1980), and Stuart and McCulloch (1980), however, these studies while identifying many of the environmental and business influences on innovation and technology in New Zealand, overlooked the specific areas of the Product Development process or the activities of innovation within the small New Zealand company.

Stuart and McCulloch (1980) did however provide many insights into the dynamics of the small company in this country in terms of new technologies. They surveyed 907 small and large companies from all industry groups. They found that the main source of new technology was the adaption of ideas from overseas trade publications and journals. Only a quarter of companies considered in-house development a source of new technology, with few looking to local sources for assistance such as other firms, suppliers, research associations, and universities. Stuart and McCulloch (1980) recommended the establishment of networks to assist small companies, particularly in promoting subcontracting. An analysis of the main problems these companies faced were increasing costs, government regulations, and developing new products. They made the observation that smaller firms tended to be more government dependent, particularly for aspects of technology and market research. In summary they said that the responsibility for some of the key areas in new Product Development was being ascribed to government and that the manufacturing industry was generally risk-adverse with little flair for dealing with competition. These conditions existed under the pre-deregulation regime so may not be totally applicable at the present time; however, many of these attitudes may still be in evidence, particularly in the less competitive or more traditional industries.

A study into research and development in the New Zealand manufacturing industry including both large and small companies was conducted by Healy et al. (1987). The R&D intensity, or the ratio of R&D spending to sales was a very low 0.45% with the median expenditure for small-medium companies being $15,000. It was discovered that about a third of all companies had no technically qualified persons on the staff and that the industry average was 4 graduates and 5 technicians working on R&D either full time or part time per 1000 employees. Most companies did not have R&D staff. In trying to assess what type of development was most commonly performed, Healy found that the companies were applying R&D about equally to developing **new** products, processes, services or systems, and **significantly improving** existing products. Finally, the use of outside R&D agencies was low - private consultants, 5%; government research agencies, 4%;

universities, and technical institutes, 1%. Again, this report suggested that the level of research and development activity in the New Zealand manufacturing industry was low.

A small survey of 23 small manufacturing businesses in the Palmerston North region was conducted by Deo (1983) to investigate the general problems faced by these companies. All of the companies used an accountant as a management consultant, however most believed that external services were too costly and so were seldom used. Perhaps the most significant finding of this study in relation to the present research was that none of these companies interviewed actually conducted R&D for future expansion or diversification, citing as a reason for not doing any R&D, that only big companies and experts conducted R&D because it required a lot of resources. This attitude would be greatly influenced by their large subcontracting components of the businesses (75% did subcontracting work for other larger firms), and the probably very traditional nature of their manufacturing businesses, requiring little new product research.

MacDonald and Mitchell (1987) attempted to analyse the attitudes to and management of research and development by New Zealand business by interviewing 44 companies over a large size range. They investigated the formality of organisational structures, R&D funding, and protecting the results of R&D however the results were somewhat general and inconclusive. The companies surveyed stated that they were not doing much R&D because, in their industry, innovation did not make the biggest profits; marketing, quality control, or service standards did. Similarly, problems perceived as impediments to internal company R&D were lack of profitable ideas, buying in overseas R&D was cheaper, the crowding out of R&D by research associations, and lack of skilled staff. Unprofitable R&D projects were not usually caused by technical failure but an unexpected small demand for the product. This result would suggest that an overall lack of marketing skills in these manufacturing companies caused these areas to be overlooked, to the detriment of the company.

Finally, a study conducted on the 130 highest polling R&D companies investigated the understanding and adoption of technology strategy within New Zealand industry (Johnston, 1991). Export led companies had either offensive (first to market) or defensive (fast follower) competitive strategies. In contrast, those serving the domestic market had imitative or dependent competitor strategies with cost reductions and customer-driven product modifications. Similarly, those companies with an offensive strategy had 94% of sales from products introduced in the past five years compared with 28% for those with imitative or defensive strategies and the majority of

exporters were reported to be strongly committed to new Product Development. There was found to be a strong link between having a niche market focus and an export orientation. Furthermore, these companies generally had a smaller turnover but higher company R&D intensities (4.56% of sales). Although New Zealand had a low national R&D intensity of 0.3% GDP, those few companies doing R&D did so at internationally competitive levels. The major sources of technology intelligence were suppliers and customers. These results suggest that companies with offensive or export strategies undertake more R&D and more Product Development.

The research into R&D in New Zealand suggests that there is actually little R&D conducted in the private sector in this country. Typically, very few employees actually have a defined role for R&D, companies face many problems, they rely on others for ideas and technology, and little time is spent of doing R&D. Those few companies that are committed to R&D, do so at internationally comparable levels. If it is implied that R&D is an essential part of the Product Development process, then the level of R&D could be a reflection of the level of undertaking of Product Development in New Zealand.

4.3 Discussion of the New Zealand Environment for Product Development

Current Product Development practice by companies in New Zealand may be influenced by past negative factors which have been reported to include:

- little research conducted into Product Development in New Zealand
- very low levels of R&D spending both by Government and by the private sector
- little perceived need for developing new products
- few employees engaged in Product Development or R&D

Although dramatic changes to the economic environment have greatly improved general company practice, the lack of experience or knowledge of conducting R&D may still affect the undertaking of Product Development. With so many years of protectionism and isolation from global competitive forces, a great deal of learning in terms of how to accurately and effectively develop new products must occur, or perhaps still needs to occur.

From the review of the literature on the New Zealand environment and the R&D studies conducted into local companies, it is possible to make assumptions as to how the undertaking of Product Development may be affected in New Zealand.

5.0 THESIS DEVELOPMENT

A review of the literature determined many of the central issues of Product Development and how they related to the aims of this research. The key Product Development issues revolved around the Product Development process and techniques, management attitudes and practice, and the success or otherwise of the resulting products. These central issues helped construct the following hypotheses for this research investigation. Having investigated how small companies approach Product Development and the influences the New Zealand environment might have in terms of companies conducting Product Development, we may have expected from this survey to find that small New Zealand manufacturing companies have:

- **a truncated, informal Product Development process missing many vital stages**
- **use very simple techniques to collect information and analyse the developing product suitability to the marketplace**
- **relatively lower levels of Product Development practice than have been reported by overseas studies**
- **little knowledge, guidance or attention to Product Development from management**
- **little time, money, resources, and people awarded to Product Development**
- **mixed success rates of introduced products, but have potentially innovative products.**

This study, however, was mainly concerned with exploratory research into the Product Development practices in New Zealand and so these hypotheses were not rigorously tested. In order to obtain relevant information on New Zealand Product Development practice and address these hypotheses, the following questions had to be answered by this study:

- How is Product Development conducted in small companies in New Zealand? Do they use a recognised development process and what is the level of sophistication of the techniques they use to actually develop products? Furthermore, how does this compare with overseas practice and theory, both in large and small companies?

- What is the level of awareness of New Zealand small company managers of the purpose and importance of Product Development to their companies? Also, what are their opinions and attitudes towards many of the issues and theory governing Product Development? And, how do these attitudes affect the practice of Product Development in these companies?

- Are there identifiable conditions or factors within New Zealand's small companies that are influencing the success of Product Development?

- Does Product Development practice and attitudes vary among different manufacturing sectors in New Zealand and between companies selling products and those selling services?

6.0 METHODOLOGY

Small companies were selected to be the focus of this research because small companies make up the majority of the local business community. Furthermore, most research has been conducted into large companies or high-technology small companies. It was the purpose of this research to be applicable to the majority of New Zealand companies, not just a small percentage in a specific field.

A range of different manufacturing sectors, and one service sector,were included in the survey to allow for a comparison among them of their practices and attitudes. The following industries were chosen by the author:

* the food manufacturing industry
* the electronics industry
* the light engineering industry, and
* the tourism industry.

The food industry was selected because these companies typically produce many new products and had perhaps more accessibility to overseas literature on Product Development and its techniques, thus they should display moderate to high levels of Product Development activity. Electronic companies were selected as most overseas studies on Product Development and particularly on small companies, have analysed high-tech companies, usually including electronics. This industry was assumed to have high levels of innovative activity and research because of the rate of new technologies. The general category of light engineering was selected as an industry that is more traditional particularly in its products, and so could possibly record lower levels of Product Development understanding and practice.

Finally, a sample of tourism companies would, it was hoped, assess the development activities of a service-type industry and allow comparison between manufacturing and service Product Development. In this regard, tourism companies were thought to be more appropriate to this study than other service industries such as banking and insurance because tourism companies must go through an obvious progression when developing their operations and thus potentially involve pseudo-Product Development activities.

Due to the financial constraints of the study, and the need to get a more representative overview of Product Development from industry, a mailed questionnaire was thought to be the most appropriate survey method, and the one undertaken by this research effort.

6.1 Organisation of Survey

In the development of the most appropriate method to collect Product Development information it was important to be as 'respondent-friendly' as possible and to make the information required easily collectable as the general level of understanding and awareness of the subject of Product Development in New Zealand industry was low and could have posed a significant barrier for respondents participating in the research.

A questionnaire was developed to collect information on the companies' Product Development issues. Foremost in its development was an attempt to make it understandable and unthreatening to small company managers so they would be willing to participate. In order to achieve this, the questionnaire had to be simple to understand and answer, concise as possible, explain unfamiliar issues of Product Development, and be of interest to the respondent.

With these factors in mind, questions were compiled that attempted to assess many pertinent issues in Product Development. Questions were either taken and adjusted from the literature or created by the author. The overseas literature was used to compile much of the questionnaire both to address previously researched areas of Product Development, thus being relevant to the discipline, and to allow for inter-country comparisons. The most pertinent questions included Cooper and Kleinschmidts' (1986) 13 stage Product Development process and techniques which was also replicated in Spain by Sanchez and Elola (1991); a large list of important management related factors taken from many readings (Cooper, 1987; Link, 1987; de Souza, 1991); a list of important sources of new product ideas (Peterson, 1988; Pavia, 1991); a list of sources of advice (Devlin & Le Heron, 1977; Murray & Crothers, 1986; Johnston, 1991); and a large selection of demographic company data questions, many relating to the effects of Product Development such as product success (Pavia, 1990), innovativeness (de Souza, 1991), and company sales growth.

The questionnaire used for the survey is shown in Appendix I.

The questionnaire was split into two sections; the first dealing with Product Development management issues was asked to be completed by the company manager, the second dealing more with the practical implementation of Product Development was asked to be completed by the person in the company with the most responsibility for this discipline. The reason for the differentiation was to prevent false reporting of Product Development activities and techniques by managers who did not have direct contact with, and therefore incomplete understanding of, Product Development practice within their companies. In most cases, however, it was anticipated that small business managers would be involved in Product Development and therefore answer both sections.

Finally, in order to persuade small business managers to complete the questionnaires, a covering letter informed them that respondents would receive a brief summary of the research once it was completed. Furthermore, because of time constraints or if for any other reasons, they could not answer the questionnaire, they were asked to write these reasons on the back of the questionnaire and send it back anyway. This would assist in the analysis of non-respondents.

6.2 Pilot Study

Once the questionnaire was compiled it was necessary to test it in a pilot study. The questionnaires were sent with covering letters to 20 small manufacturing business in Palmerston North. The companies, found from a City Council manufacturing database, represented the industries of electronics, food, and furniture. Six questionnaires were returned completed. These appeared to be adequately understood by the company managers and no problem with the question content was found suggesting that they were not too complicated and were able to be completed. Slight adjustments were made to the coding of the questionnaires so that if returned completely unanswered then the company could still be identified.

6.3 The Full Survey

In order to send out the questionnaires in a New Zealand wide survey, it was first necessary to obtain company names. This, it was discovered, was not an easy task with many of the obvious sources of listing information being too expensive or inappropriate. Similarly, obtaining information by which to classify the companies as small or relevant to Product Development was also challenging. Manufacturing companies that were largely subcontracting based were not considered appropriate as their level of understanding and practice of Product Development would be low more often than not. Electronics and engineering companies were finally found from the New Zealand Business Who's Who (1991) and the New Zealand Manufacturers' Federation members listing; tourism companies were identified from selected lists provided by the New Zealand Tourism Board; and most food companies were obtained from respondents to a previous study into the food industry (Putt, 1993). In all, 312 questionnaires were mailed out amongst the four industry types throughout the country in April 1993. After two weeks a reminder letter was sent to those companies who had not yet responded. The companies were asked to return the questionnaires within three weeks although they were accepted up to five weeks after first mailing out.

Although this study involved predominantly exploratory research, in some instances statistical analyses were conducted in order to make relevant comparisons. Correlations were used to determine if factors were related. This provided a means for summarising the relationship between two variables in terms of both degree and direction, recognising that statistical correlations do not establish causation and that post-hoc explanations can also be oversimplified or incorrect. Only significant correlations at the level of $p \leq 0.05$ or $p \leq 0.01$ were reported in the results. At this level of probability, it is unlikely that the relationships were caused by chance. T-tests were conducted to assess significant differences between factors. Once again, only those significant differences or significant non-differences were reported.

6.4 Response Rate

The following are the total number of questionnaires returned for each industry type, including non-completed responses which were the questionnaires sent back with explanations of why they could not be answered. The total number of questionnaires returned and the total number completed are shown in Table 1.

Table 1. Questionnaire Responses

INDUSTRY	TOTAL SENT	TOTAL RETURNED	TOTAL USEABLE RESPONSES	RESPONSE RATE (%)
Food	92	37	31	33.7%
Electronics	72	40	28	38.9%
Light Engineering	89	40	25	28.1%
TOTAL	**253**	**117**	**84**	**33.2%**
Tourism	59	24	16	27.1%

The reasons given by the people who returned the 33 non-completed forms were; the person most responsible for Product Development was away; the company did not do Product Development; and, they did not have the time to respond. These reasons could possibly have been applied and generalised to the non-responding population, thus providing an insight into the differences between responding and non-responding companies.

The typical response rate for this type of survey has been suggested by Pavia (1991) to be in the range between 20-30% so this survey, at 33.2%, was acceptable. The high mortality rate of small businesses coupled with the possibly out-dated and often incorrect nature of databases would suggest that the actual response rate was higher than this figure.

6.5 Company Age and Size

The mean age of all manufacturing industries was 18.5 years (ranging between 1 and 50 years) and the mean number of employees was 16.4 (ranging from 1 to 50 employees). Table 2 shows the mean age and size of the companies by industry and Table 3 details the number and age of companies in each size category and for each industry.

Table 2 **Age and Size of Companies by Industry**

Industry	Number of Employees	Mean Age (years)	n (n=79)
Food	18.4	16.4	28
Electronics	14.8	21.2	26
Light Eng	16.0	18.1	25

Table 3 **Number and Age of Companies by Size and Industry**

Industry	Size (employees)	Number of Companies (n=77)	Mean Age (years)
Food			
	0-10	11	19
	11-20	6	16
	21-30	6	15
	31-40	4	10
	41-50	1	15
Electronics			
	0-10	9	16
	11-20	11	19
	21-30	3	32
	31-40	2	36
	41-50	1	43
Light Engineering			
	0-10	8	17
	11-20	11	16
	21-30	0	-
	31-40	2	28
	41-50	2	25

Table 3 shows that as the size of the electronics and light engineering companies increased, the age of the companies also increased, although there was no significant relationship found between company age and employee numbers. Food companies on the other hand, generally remained a similar average age for the increasing size range.

Table 3 details that the vast majority (73%) of the companies surveyed were under twenty employees in size. Similarly, Table 3 shows that small companies are well established. The general pretence that small companies come and go at a high rate does not hold, at least for this survey.

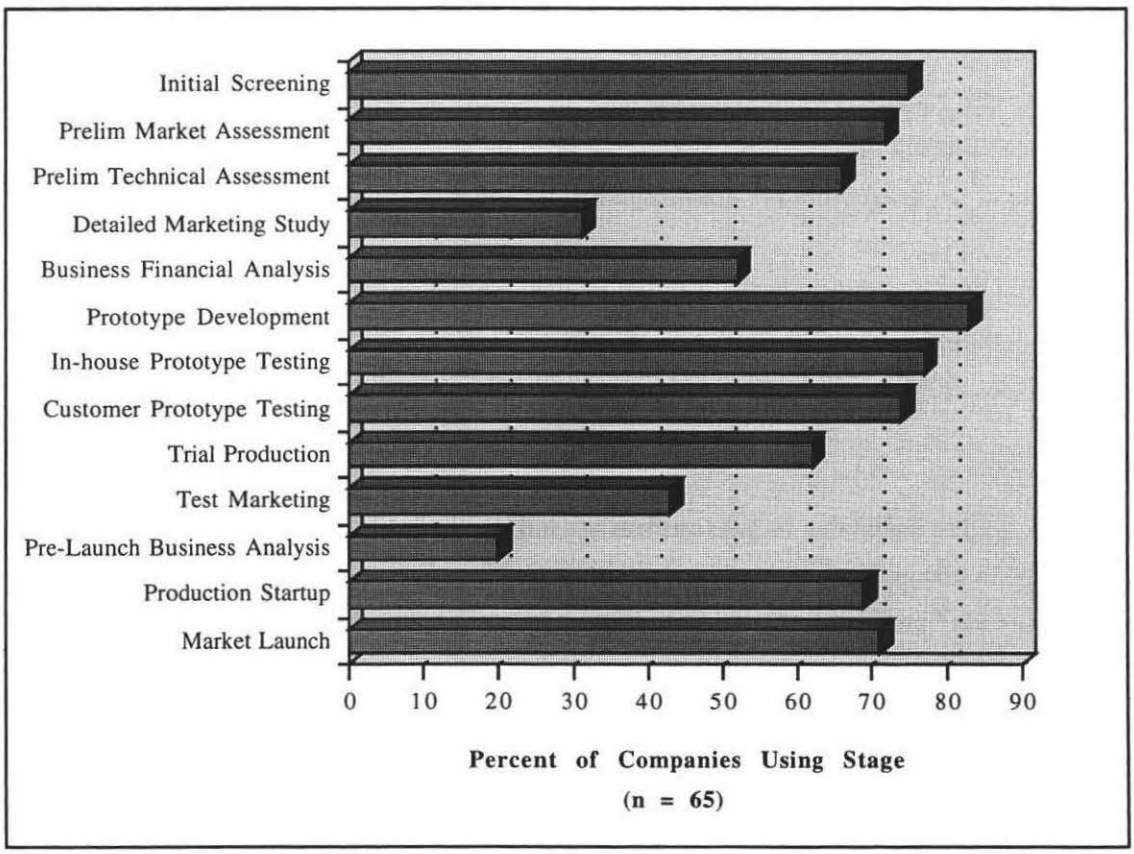
7.0 THE PRODUCT DEVELOPMENT PROCESS

One of the major aims of this study was to assess the type of Product Development activities undertaken by New Zealand small manufacturing companies and to determine now structured their development processes were.

7.1 The Product Development Stages Used

The respondents were asked to select which activities they commonly used in developing their new products from screening new product ideas through to market launch. In an attempt to avoid respondent problems through differences in terminology of the stage titles, brief descriptions of the aims of each stage were given. Figure 1 shows the number of companies that used the different stages in developing their new products.

Figure 1 Frequency of Product Development Stages



It can be seen that detailed market study, business financial analysis, test marketing, and pre-commercialisation business analysis were seldom used as activities in the development of new products.

This result would tend to suggest that small companies either do not have skills in these areas or they do not deem them necessary to conduct. The purpose of conducting a financial analysis is to gauge if the investment will return a reasonable return for the company before many resources are committed to commercialisation and launch. Even if companies were closely in touch with technology trends, the market and the consumer, these factors change over the course of a development project and to not re-visit these issues to check the financial viability of the new product is a risky approach. Market research is undertaken to ensure the company understands the market size, competitors, the consumer, and pricing structures, and can develop a product to satisfy them given the capabilities of the company. A high-tech, well-engineered, efficiently-produced product is useless if it cannot provide the right combination of user benefits at the right price (and of course at the right time).

The implication of these findings is that prior to the product being introduced to the market, the company has little appreciation of either the market size or the potential financial return of the product. A dangerous approach one would suggest given the resources and commitment required to introduce a new product, only to find it has an 'unexpectedly small demand' or is unprofitable.

Generally, the companies exhibited moderate uses of Product Development stages. However, only 83% believed they constructed a prototype, a fundamental activity one would suggest, and only 71% indicated they launched or introduced the product to the market. The reasons behind these low percentages are unknown.

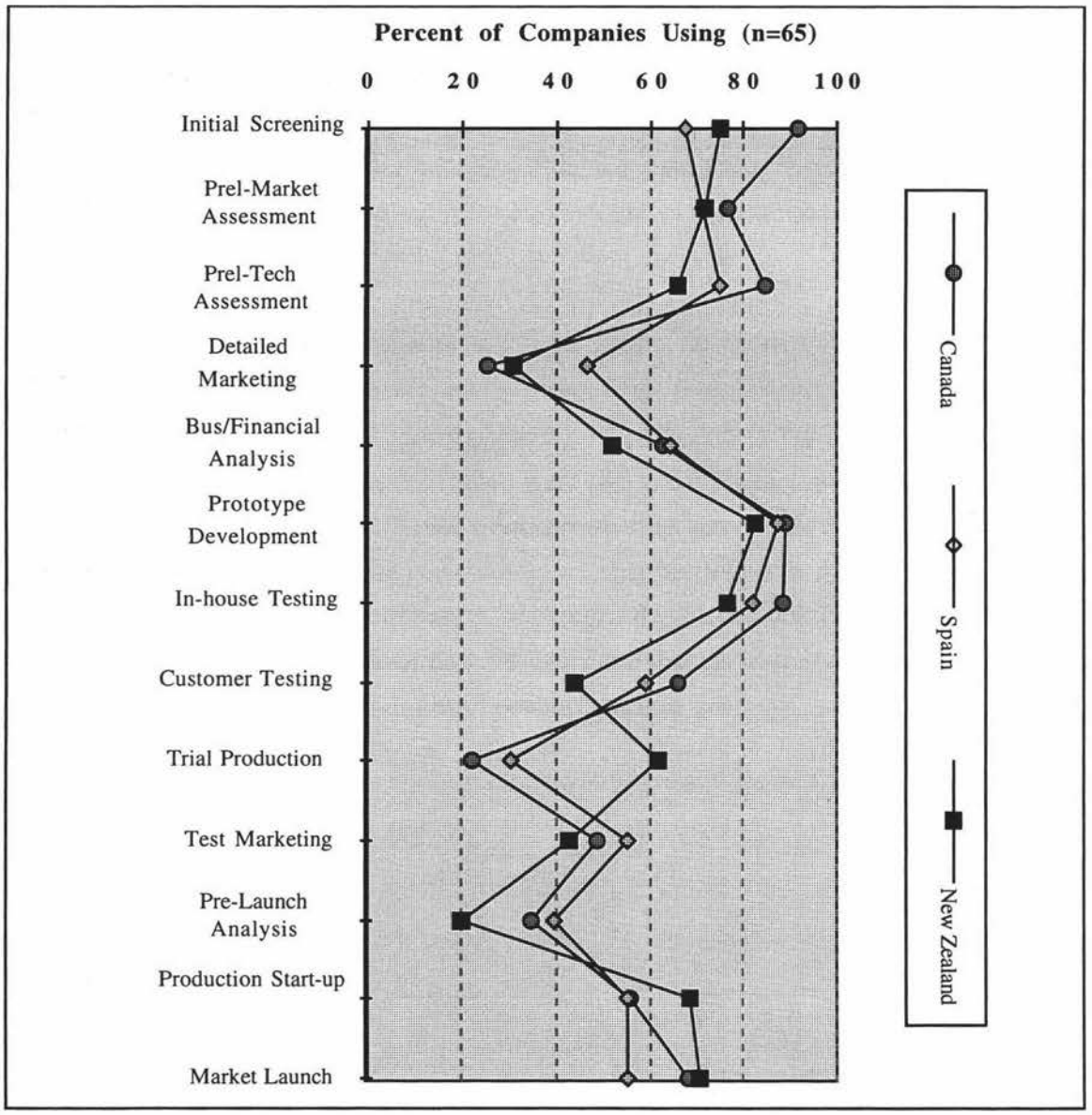
Cooper and Kleinschmidt (1986) determined that the undertaking of a detailed market study and business/financial analysis were strongly related to the development of successful products in large Canadian companies. If the same results are transferrable to New Zealand small companies, then the lack of understanding of, or perceived need for, these activities may be seriously affecting local companies' product successes.

It would appear that the focus of the small companies Product Development efforts was on the development of the product itself, rather than the development of the total 'business proposition' that will sustain the company in the future. The stages less frequently used by New Zealand small manufacturing companies tend to be more **intangible** in nature. They involve issues such as market size, consumers' attitudes and perceptions, long-term sales levels, the answers to which are harder to find and to understand. By contrast, the activities which were used most often were initial idea screening, prototype development, and in-house prototype testing (exactly the same top three as in the Canadian study), which tend to involve the more **physical** development of the product.

These stages are more obvious to conduct as they are hands-on and the results are immediately visible. The physical development, or design of the product, would then appear more **logical** to conduct and thus receive more concentration and emphasis than the more intangible and harder to understand activities. Increasing the awareness of small company managers in areas such as marketing and business, and Product Development in general, would likely increase the use of these stages and improve the results of their Product Development efforts.

The frequency of use of the stages in New Zealand small companies was compared to the results from the similar studies of large Canadian companies (Cooper and Kleinschmidt, 1986) and small Spanish companies (Sanchez and Elola, 1991). Figure 2 compares the Product Development processes used in each country.

Figure 2. Comparison of Product Development Process Used in New Zealand, Canada and Spain



Source: Sanchez & Elola (1991)

It can be seen that New Zealand small companies follow the same general pattern of activities used as those of Canadian large companies and Spanish small companies, all peaking and troughing at the same points. Similarly, the usage rates of most of the stages were quite compatible with those of the overseas companies and generally fell close to or between the ranges of these companies. Throughout all three studies, it is the marketing and financial research stages that receive the least usage.

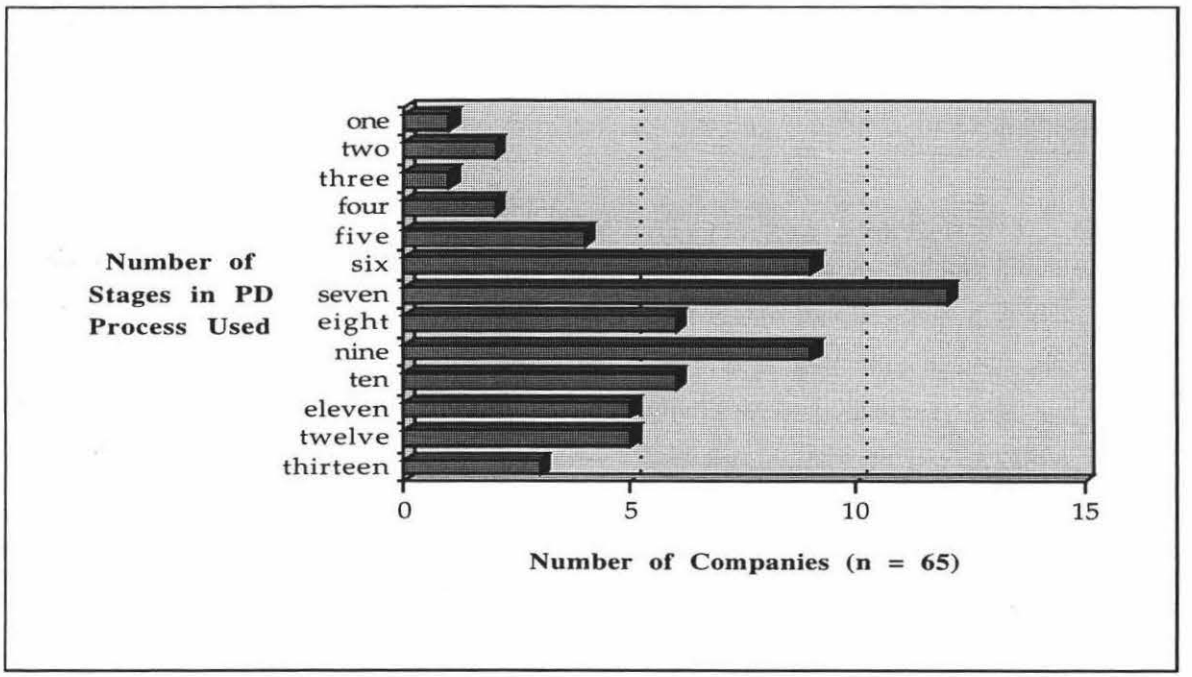
These results are interesting in terms of the international use and understanding of the Product Development process. Since the general usage trend for the stages is similar across nations and company sizes, ie. national and company size factors do not influence the overriding principles of Product Development, and the more intangible stages are the least frequently used, it would appear that the general level of understanding of the Product Development process within companies at present is similar.

There are however, some differences between the results of the studies. **The stage of pre-commercialisation business analysis is used less frequently in New Zealand small companies than their overseas counterparts**, possibly due to the lack of general business skills by our small company managers. There were two activities that rated higher in New Zealand than in the two previous studies. **Trial production and production start-up were undertaken more frequently in New Zealand companies**. It is possible given the small and therefore flexible production equipment in New Zealand small companies that it is relatively simple to do small production runs of new products and that changes in production process can relatively easily be made to suit changes in products or new products.

7.2 Completeness of the Product Development Process

An analysis of the total number of activities or stages carried out by the companies provided a measure of the completeness of the Product Development process. A more complete Product Development process, ie. with a greater number of recognised stages, would suggest that more issues have been explored in development leaving fewer important issues omitted and has repeatably been reported as a major influence on product success. Figure 3 shows the number of stages used within the companies' Product Development processes.

Figure 3. Completeness of the Product Development Process



The Product Development processes of the small manufacturing companies varied from utilising only 1 stage to using all 13 stages. Almost half (47.7%) of the companies carried out seven or less activities, ie. half of the stages in the Product Development process, which suggests that these companies are omitting a large number of vital stages in development. Cooper & Kleinschmidt (1986) found this figure to be 32.7% in Canada. This has previously been found to have implications for the development and success of companies' products. It was most common, however, for companies to have a process of between 6 and 9 stages with the mean being 8 stages.

One can assume that a company using only seven stages in Product Development, and hence not analysing six areas important to the development of new products, stands more of a chance of introducing a product to the market that is deficient in some aspect such as incompatible with existing distribution channels, ergonomically poor, not meeting standards, or most commonly, achieving poor market demand.

A somewhat truncated process could have been expected for incremental Product Development or product improvements (however, most of the products the companies developed were reported to be quite innovative (described in section 7.4.4)). Similarly, if people working in Product Development believe they are already cognitive of product standards, market needs, and production methods they will not see the need to conduct these stages and hence their Product Development process will consist of fewer stages.

The completeness of the development process was significantly correlated ($P<0.05$) to the innovative success (explained in a following section) of the companies' products . This suggested that completing more of the prescribed stages of the Product Development process results in a more successful product. This is a most significant result in that it tends to support Product Development theory and was also found by Cooper and Kleinschmidt (1986), Boag and Rinholm (1989), and Hise et al.(1989). In terms of product success it seems logical, as stated above, that analysing the idea or product more completely during development for market acceptance, manufacturability, distribution compatibility, existing technologies, and financial viability, will prepare the product and the company better for its introduction to the marketplace. Those undertaking few stages are incurring a degree of risk.

The completeness of the Product Development process was also correlated to the managers agreement that new products were important to the future success of the company ($P \leq 0.05$). Managements views on the importance of generating new products appeared to relate to the conducting of more stages of the Product Development process.

A comparison of the number of stages used by companies over the various company size ranges indicated that the average number of stages used for most sized companies was 6 stages, ie. omitting over half of the stages important to the development of the product. Companies between the size of 30 - 40 employees, however, used on average 9 development stages in their process as shown in Table 4.

Table 4 Number of Product Development Stages by Company Size

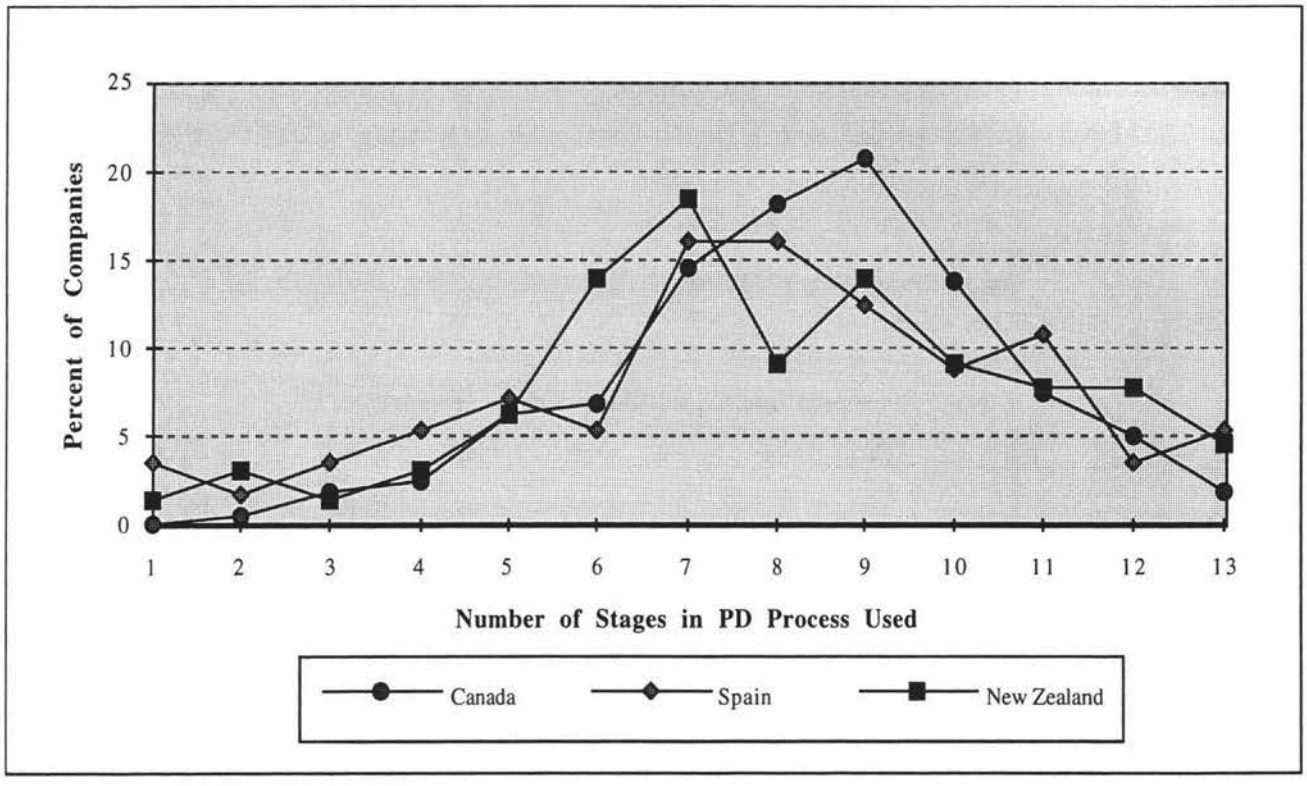
Company Size	Mean Number of Stages	n
0 - 10	5.9	30
11 - 20	5.6	28
21 - 30	6.3	9
31 - 40	8.9	8
41 - 50	6.3	4

A comparison of the completeness of the Product Development process as used by New Zealand, Spanish, and Canadian companies is shown in Figure 4.

It can be seen once again that there is little general difference among companies in the three countries, ie. New Zealand companies generally have similar Product Development processes to the overseas companies.

Many prescribed activities in the Product Development process were not being used and as such products are not being completely developed to their full potential.

Figure 4 Overseas Comparison of Process Completion

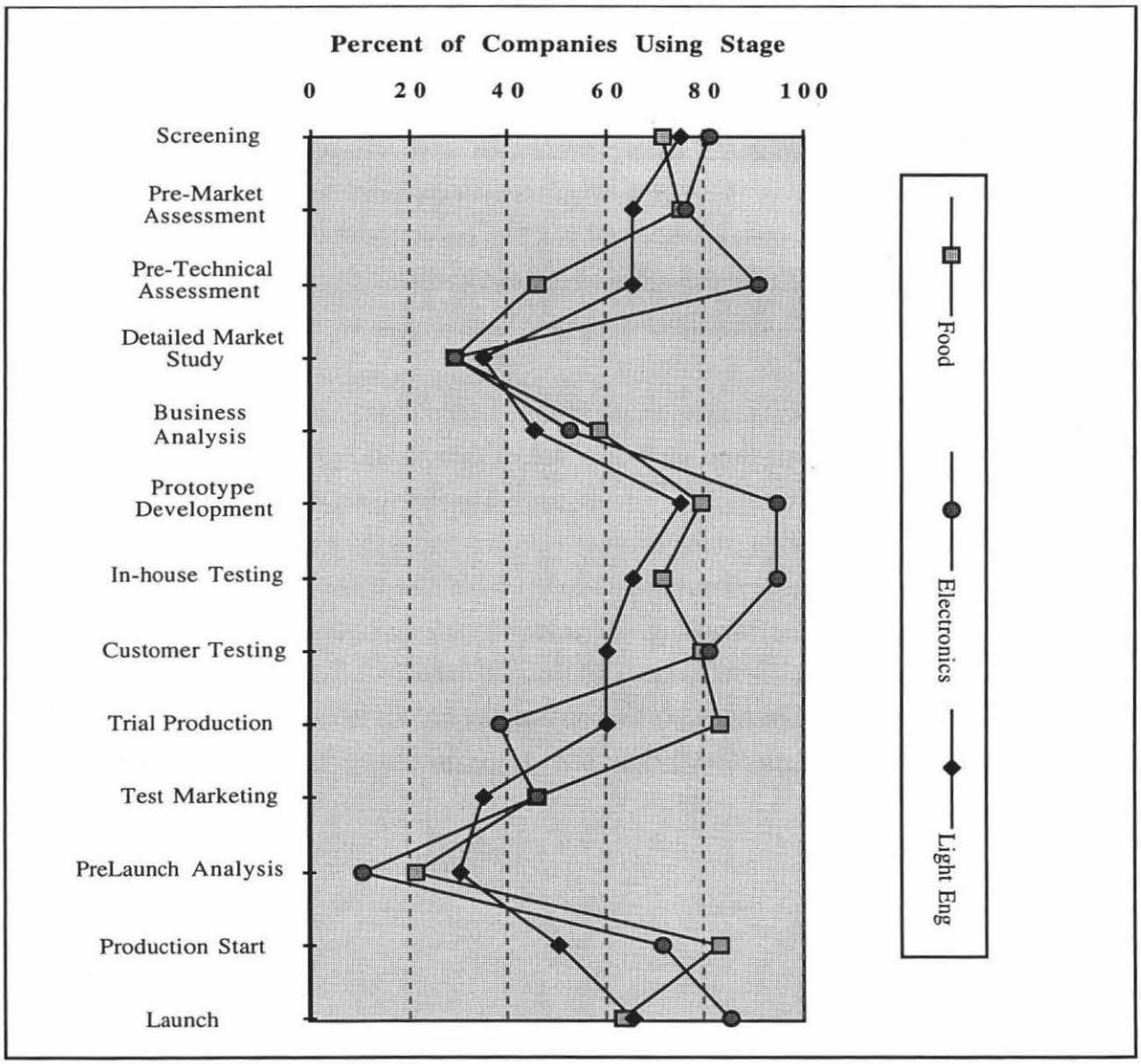


From the analysis of the literature and the similar studies investigating the type and nature of the Product Development process actually used, it can be generalised that New Zealand small companies develop products using a truncated process that omits many marketing and economic issues. This result has been determined by many previous researchers investigating development theory against industry practice (Feldman and Page, 1984; Cooper and Kleinschmidt, 1986; Moore, 1987; Boag and Rinholm, 1989; and Sanchez and Elola, 1991). This research confirms many of these previous findings, and suggests that the New Zealand small company Product Development practice is very similar to overseas practices.

7.3 New Zealand Industry Comparisons of Product Development Process Used

Figure 5 compares the Product Development process of the three manufacturing industries. **Once again, the Product Development processes of all three industries are fairly similar.**

Figure 5 The Product Development Process over the Industries



Electronics companies demonstrated more involvement with the technical development of the products. Preliminary Technical Assessment, Prototype Development, and In-house Prototype Testing were all conducted more frequently in electronics companies. Interestingly, electronics companies also used the Market Launch more frequently than the others. Electronics companies recorded the mean highest level of use for 8 of the 13 stages as compared with food companies with 3 highest and light engineering with 2.

Food companies undertook less Preliminary Technical Assessments but more Trial Productions. Food companies appeared to be using existing knowledge of food ingredients and production but with their flexible production equipment, experiment to optimise the formulation or processes.

Light Engineering companies less frequently used Customer Testing of the Prototype and Production Start-up suggesting that they roll into production using existing jigs and equipment in an informal manner and that they may produce for existing design specifications or see little need to involve the customer. Light engineering companies recorded the lowest mean level of use for the stages, recording the lowest use for 7 of the 13 stages.

Comparing the completeness of the Product Development process among the three industries showed little difference but the electronics sector utilised the most number of stages, on average 6.4, food used 6.2, and light engineering 5.8 stages.

The hypothesis that the more high-tech nature of electronics companies will be reflected in their greater use of technical development stages does appear to have some merit as well as the suggestion that they are more involved in conducting Product Development. Food companies did not display more frequent use of the marketing stages as expected and light engineering companies were slightly more traditional in their approach to Product Development.

7.4 Summary of the New Zealand Small Company Product Development Process

The following are the characteristics of the Product Development process used by these New Zealand small manufacturing companies.

- The Product Development process was missing vital stages that investigate issues involved with the targeting and profitability of the product, demonstrating lesser perceived need for, or ability to conduct research into, these issues. There was an emphasis on the tangible or physical development of the product.

- The level of use of the process stages was very similar to overseas practices indicating that there exists a base level of understanding and practice of Product Development which applies regardless of demographics or geographics.

- The Product Development process was very truncated in the majority of companies, most companies using only eight or less of the thirteen prescribed stages suggesting that products are introduced to the market incompletely developed. This is a risky practice.

- In comparison to overseas practice, New Zealand companies generally used fewer Product Development stages within their processes but the nature of the processes were very similar.

- Within the New Zealand manufacturing industry, different sectors placed greater emphasis on different issues in developing their new products. Electronics companies conducted higher levels of research into technical issues and generally undertake more product development efforts than the other industries.

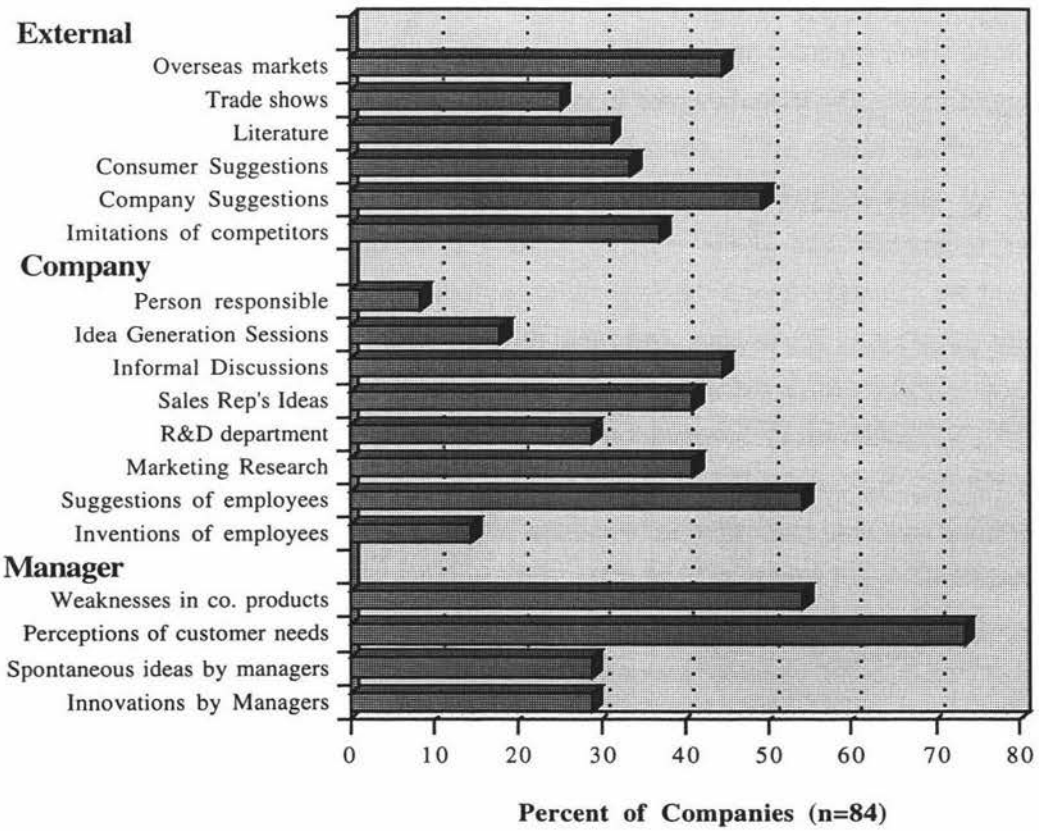
8.0 TECHNIQUES USED WITHIN PRODUCT DEVELOPMENT

In order to more fully understand how New Zealand small companies actually conducted Product Development, a more in-depth analysis of their development activities was carried out. The Product Development process acts as a **management tool** but what actually occurs in development, ie., the techniques used, more accurately depicts Product Development understanding and formality.

8.1 Important Sources of New Product Ideas

An analysis investigating the main sources of new product ideas for New Zealand's small manufacturing industries was undertaken in order to assess how companies generate their new product ideas. This stage of the Product Development process is crucial as it is the initiator for the rest of the development process and influences the innovativeness of the final product. Figure 6 shows where companies obtain their new product ideas. The source of ideas were grouped into those from outside the company, inside the company, and those originated by the manager.

Figure 6. Important Sources of New Product Ideas



Managers perceptions of customer problems and needs was an important source of new product ideas for the majority of companies. Observations of weaknesses in existing company products by managers and suggestions by employees were also used by the majority of companies. Managers appeared to be the most important idea generation source for the small companies.

The key role of management in product idea generation was also the result determined by de Souza (1991) in Australia. Managers once again, therefore, play a major role in Product Development by being the major source of new product ideas for the company. These product ideas appeared to result through the direct contact of managers with customers, the market, and competitors' products, as they were able to observe product weaknesses and determine customer needs. In larger companies, these tasks are the role of marketing, sales, and technical staff. Petersen (1988) found that employee suggestions were the largest source of new product ideas in small American manufacturing companies.

Customer suggestions had previously been found to be one of the most important sources of new product ideas (Cooper & Kleinschmidt, 1986; Pavia, 1991; Sanchez & Elola, 1991). In this study it was decided to separate 'suggestions by customers' into 'other company suggestions' and 'consumer suggestions' as they are the ultimate user of the product in order to differentiate between the two. This had not been attempted in any previous study. **The results indicated that there was a difference between the two types of customers. Suggestions by company customers were ranked fourth as a source of new ideas but consumer customers were only ranked tenth.** This differentiation indicates that other companies are more important than the individual consumer when dealing with ideas from customers. Other companies could include suppliers, vendors, or retailers. Previous research may have misleadingly assumed that customers meant individual consumers whereas this not necessarily the case.

One of the main findings from the analysis of sources of new product idea was that the more structured or systematic methods of finding ideas, such as idea generation sessions, an employee scanning the environment for new ideas, R&D department, literature, and trade shows were used as ideas sources by less than a third of companies. Informal methods that cause ideas to arise by chance, suggestions, or daily operations were much more prevalent as sources of new product ideas. This reactive approach does not fully utilise the potential of the environment, the company, or its employees in terms of generating creative new ideas. Overall, these New Zealand small

companies gathered new product ideas from a wide variety of sources although the manager played a key role.

A comparison of how active the industries were in using different idea sources, suggested that light engineering companies utilised more sources of ideas than the rest as shown in Table 5.

Table 5 Average Number of Idea Sources used per Industry

Industry	Number of Sources Used	N
Food	6.8	31
Electronics	6.4	28
Light Engineering	7.3	25

The companies were asked where they perceived themselves to be on a 5-pt scale depicting the proactiveness of their approach to generating new ideas. On average the companies considered themselves to be proactive in their methods of generating ideas. Peterson (1988) and Pavia (1991) both determined that companies they surveyed used unstructured and informal approaches to generating new product ideas and that they could greatly benefit through giving more attention and structure to this process. Although the small companies in this survey believed they were quite proactive in generating new ideas, the above analysis of the nature of the ideas sources they used to generate ideas tends to suggest that they relied heavily on informal methods rather than the more structured approaches of actively generating ideas.

8.2 Techniques of Product Development

The companies were asked what techniques they actually used in the development of their products. From a large list of techniques for each stage, the respondents chose those most appropriate to their practices. The results are shown in Table 6. For the sake of clarity, the techniques have been broken into three stages; pre-development, development, and commercialisation. Companies could select any techniques they used (ie. percent ≥ 100%).

Table 6 Pre-Development Techniques Used in Product Development

Technique	Percent of companies NZ	Canada	Spain
Idea Screening			
A group decision based on no formal criteria	**58.0**	59.5	44.6
The manager made the decision	**27.2**	-	-
A single individual with no formal criteria	**17.2**	23.7	25.0
A single individual with formal criteria	**8.6**	-	-
A group decision based on formal criteria	**7.4**	11.6	30.3
Preliminary Market Assessment			
Direct contact with customers	**55.6**	46.3	73.2
Knew market already: intuition	**44.4**	8.3	28.6
Review of competitors products	**37.0**	9.1	62.5
Discussions with the sales force	**29.6**	9.9	44.6
Casual discussions with retailers/suppliers	**24.7**	-	-
Assess secondary/published data	**12.3**	8.3	37.5
Preliminary Technical Assessment			
Product design/model development	**53.1**	8.6	76.8
Product specifications/recipe	**43.2**	10.2	67.8
Capability analysis	**37.0**	30.5	58.9
Engineers/designers/scientists assessment	**24.7**	28.9	35.7
Literature investigation	**14.8**	-	-
Detailed Market Studies			
A study of competitors products and prices	**51.9**	25.9	69.6
A study of what customers needed or wanted	**48.1**	18.5	39.3
A study to determine market size	**28.4**	18.5	17.8
Concept testing of idea	**18.5**	-	-
Business/Financial Analysis			
Costs and sales forecasts	**55.6**	31.2	73.2
Payback period/break-even analysis	**27.2**	18.3	33.9
Return-on-investment analysis	**23.5**	28.0	21.4
Superficial analysis: rough guesses	**22.2**	14.0	-
Discounted cash flow analysis	**9.9**	30.5	14.3

Initial Screening

The most commonly used method to screen possible new product ideas was a group decision using informal criteria, followed by the manager making the decision, and then a single individual again using informal criteria. This demonstrates that the vast majority of screening decisions are made without any formal criteria on which to base the decision. As a consequence of this informality, products may be pursued loosely based on personal and subjective perceptions. Informality governed the initiation of development projects within these New Zealand small companies, perturbing if a poor idea is accepted and allowed to continue through development, obviously committing scarce resources. An assessment of the new product idea's market potential and company compatibility should be the minimum criteria used for screening. If criteria like these are written down, then it forces people to evaluate them, rather than risking them and their implications not being considered.

Rather than the usual practice of a formal idea generation stage, it is possible that in the small company someone comes up with a single product idea and so there would be no need to compare new ideas in the usual screening evaluation. The use of a group of people in the majority of screening decisions, as opposed to a single person making the decisions, was encouraging.

Spanish companies utilised group techniques to formally assess the merits of new product ideas more than the New Zealand or Canadian companies.

Preliminary Market Assessment

This stage scored relatively highly as one that was undertaken by 71% of companies. As Table 6 demonstrates, many methods were used by the small companies to investigate the market, the competition, and the nature of the products on the market. Direct contact with the customers was found to be the method used most frequently, closely followed by market intuition and a review of competitors' products. These approaches, particularly market intuition, suggest a casual, informal approach to market assessment.

Spanish companies demonstrated that they were very active in conducting preliminary market research and frequently used a wide range of techniques. In contrast to the other studies, New Zealand companies used a large amount of intuition and prior experience in assessing the market

for the product suggesting that they perceive themselves to be in touch with the market and cognitive of the customers needs and the present market situation.

Preliminary market assessment was found to be significantly correlated ($P<0.05$) to the innovation type of the company's products, ie. conducting an early market assessment appears to be indicative of the development of a product which is innovative or further departed from the normal experiences of the company. This would indeed be logical during development of a new product that the market, competitors, and consumer needs would have to be reassessed. Once again the techniques used to assess the market, products, and consumers were informal.

Preliminary Technical Assessment

A preliminary technical assessment is necessary to determine the ability of the company to develop and manufacture a new product, particularly if it involves new technologies. Product design/model development was found to be used in 53% of the companies. Product specifications and capability/feasibility analyses were also used by over a third of companies. A preliminary technical assessment should be conducted in developing an innovative new product, however, no significant relationship was found. A significant relationship does exist, however, between conducting a preliminary market assessment and a preliminary technical assessment ($P<0.05$) suggesting that these two techniques were usually carried out together.

Spanish companies, once again, more frequently used preliminary technical assessment techniques to evaluate the new product proposition, representing a greater understanding of the necessity to conduct these assessments. Few Canadian companies build models to assess the technical merits of the product.

Detailed Market Research

This stage was found to be amongst the lowest in importance in the small company development processes. A study of competitors' products and prices and a study of what customers needed in the new product were the methods cited as being used most often by around 50% of the companies. Concept testing, a commonly prescribed technique prescribed by academics was used in some form by 19% of small companies.

New Zealand companies recorded the highest use of studies to determine customers needs and wants and studies to determine market size reflecting a greater need to establish potential sales volume for the product. The small nature of the New Zealand market may necessitate this attitude.

Business/Financial Analysis

This stage is a most important one as it assesses the information obtained in a project to determine the commercial potential of the product before further resources are committed. 56% of the companies used costs and sales forecasts to conduct this analysis. The more complex techniques as promoted by finance specialists such as return-on-investment and discounted cash flow analysis were seldom used; in 22% of companies rough guesses were used to evaluate the viability of the project.

Canadian companies exhibited greater uses of the more detailed financial analysis techniques than did Spanish and New Zealand companies who typically use simple analyses.

Table 7 **Product Design & Development Techniques Used in Product Development**

Technique	Percent of Companies NZ	Canada	Spain
Prototype Development			
Carefully constructed: drawings/specifications	**53.1**	-	-
Rough 'knock-up'	**33.3**	-	-
Contracted out	**9.9**	-	-
In-House Prototype Testing			
Prototype testing: functioned properly	**58.0**	32.5	80.4
Operating tests: under real-life conditions	**51.9**	28.5	73.2
Field tests of the product	**32.1**	7.1	-
Specifications/standards check	**28.4**	26.2	80.3
Customer Prototype Testing			
Giving a sample to customers to try	**72.8**	77.9	-
Reactions at trade shows	**18.5**	-	-
On-site customer user tests	**9.9**	7.1	-
Designed customer testing with procedures	**6.2**	14.2	-
Trial Production			
A test of the production system itself	**40.7**	53.7	-
Testing the product from the production system	**35.8**	41.8	-

Prototype Development

This stage was undertaken by the majority of companies (83%) and was seen as being the most relevant to small companies. It is fundamental to develop a prototype to analyse a new product idea in any development process. It was found that 53% of companies actually used design drawings

and specifications to construct their prototypes which is a formal approach to this most important activity. Then again, a full third said they made a rough 'knock-up'.

Prototype In-House Testing

This was another stage that was seen as being important to the development efforts and highly utilised. The majority of the companies used both functioning tests and real-life operating tests to assess their prototypes. Operating tests included such activities as shelf life assessment and reliability testing.

Spanish companies were found to be very much involved in using techniques that test the prototype in-house. These involved testing the physical or technical abilities of the prototype. Spanish companies place greater importance on physically testing the prototype.

Prototype Customer Testing

It was surprising to find the high level of acceptance and practice placed on this activity within the small companies. It would seem that these companies realised the importance of having customer input in the development of new products. In an attempt to utilise the customer the vast majority of companies gave a sample of the prototype to customers to try. The question remains, however, if the customers who were given the prototype to try were actually those representative of the target market, ie. ultimately the ones who would purchase and use the product. The more formal methods of customer research in prototype evaluations, eg. on-site customer tests, designed customer tests with procedures, were hardly used (less than 10% of companies).

Trial Production

A test of the production system and tests on the product produced from the production system were equally used by the companies. **Conducting a trial production was also found to be related to the innovation type of the companies' products ($P \leq 0.05$).** A new product must be assessed as to its ability to be produced efficiently and a new product that is quite removed from the typical operations of the company would have to require a new method of production.

Table 8 Commercialisation Techniques Used in Product Development

Technique	Percent of Companies NZ	Canada	Spain
Test Marketing			
Selling to a sample of selected customers only	**24.7**	48.4	-
Selling on a very limited basis	**19.8**	-	-
Selling in a limited geographic area	**18.5**	32.2	-
Selling in one or two stores on a trial basis	**2.5**	-	-
Pre-Introduction Business Analysis			
A cost review: production, distribution, marketing	**39.5**	19.6	53.6
A review of marketing information only	**23.5**	23.9	48.2
A detailed financial analysis	**13.6**	34.8	28.6
Production Start-Up			
Involved few changes to existing production facilities	**42.0**	35.0	-
Involved no change to existing production facilities	**28.4**	12.5	-
Acquisition of new equipment or facilities	**16.1**	31.3	-
Market Launch			
Prepared trade literature and advertising	**54.7**	35.8	35.7
Demonstrated at trade shows	**28.4**	-	-
Very limited efforts	**28.4**	17.0	12.5
Customer (public) advertising	**25.9**	-	-
Media Attention	**12.3**	-	-

Test Market/Trial Sell

One of the least used stages, the test market was most commonly undertaken by selling the product to a sample of selected customers. The technique of selling a product in a few stores was used by only two companies. In comparison with New Zealand companies, Canadian companies place more attention in test marketing.

Pre-Launch Business Analysis

It was found earlier that 70% of all companies conducted this stage as part of their Product Development process and it was perceived by managers as being the least important to small businesses. The most common method was a review of distribution, production, and marketing costs with few companies actually using a detailed financial analysis to measure the return or profitability of the product.

Spanish companies once again demonstrated a greater need to conduct a pre-introduction business analysis.

Production Start-Up

This stage, conducted by 69% of small companies, was relatively straightforward in that the majority of cases involved either few or no changes to existing production facilities or equipment. This would suggest that most products developed are incremental in nature, not requiring new production knowledge, practice, or equipment as more radical innovations would do. In contrast, Canadian companies generally require more new equipment for the production of their new products, whereas in New Zealand, companies tend to use or adapt existing equipment.

Market Launch

Almost half of the small companies prepared trade literature and advertising to launch the product. It was not investigated who this literature was directed at, ie. industrial buyers or retailers. A relatively equal number of companies demonstrated their products at trade shows, conducted customer advertising, or made no particular efforts to launch their products. New Zealand companies tended to promote more to the trade or distributers than in other countries. This might reflect the buying power of the distribution or retail sector in New Zealand or the activities necessary to compete against larger and more entrenched competition.

The techniques used within the different stages of Product Development tend to suggest that they were rather informal in nature. Moore (1987) concluded that companies used less sophisticated, small-scale, qualitative techniques as opposed to the more sophisticated ones discussed and promoted by academics. This study supports this finding. Furthermore, market research techniques and financial analyses used were particularly more basic in nature. The more physical techniques in contrast utilised more complex techniques, ie. providing more detailed analysis and information, in the stages of preliminary technical assessment, prototype development, and in-house testing. Companies displaying more technically oriented skills and emphasis has been determined by many studies suggesting that marketing skills are poorly exercised in the majority of companies both large and small (Feldman and Page, 1984; Cooper and Kleinschmidt, 1986; Moore, 1987; and Sanchez and Elola, 1991). Small companies have limited staffing resources and the most essential of functions are staffed first. Hence, production, technical, and engineering functions receive the greatest priority. Physical skills and practices are emphasised resulting in little marketing and financial expertise. The nature of the techniques used in Product Development in New Zealand small companies reflects this.

Finally, the reporting of the techniques used to conduct Product Development not only allow a greater level of insight into the sophistication of companies development efforts, it also allow a check to be made between the recognition of a Product Development process which they reported and what they actually did. For example, only 20% of companies indicated that they conducted a pre-commercialisation business analysis, however, when prompted in more detail, 39.5% of companies used a cost review to assess the financial impact of the new product. This may suggest that companies do not have a recognised, structured development process, and that they do not understand the totality of it.

In comparing the percentage of companies that use particular Product Development techniques across studies, as shown in Tables 6, 7, and 8, it can be seen that the highest polling technique for each stages is generally the same for different countries and different sized companies, ie. in their Product Development efforts, companies use similar common techniques throughout the development processes regardless of demographics or geographics.

Comparing the New Zealand practices with those of Canada and Spain suggests that the use of Product Development techniques in New Zealand small companies are more similar to those in Spanish small companies both in terms of frequency and sophistication of technique.

8.3 Industry Comparison of Number of Techniques Used

An analysis was conducted into the average number of techniques the companies used in Product Development. If one looks at the average number of techniques used by companies across the four different industries, as shown in Table 9, the **food industry utilises slightly more techniques on average per company**.

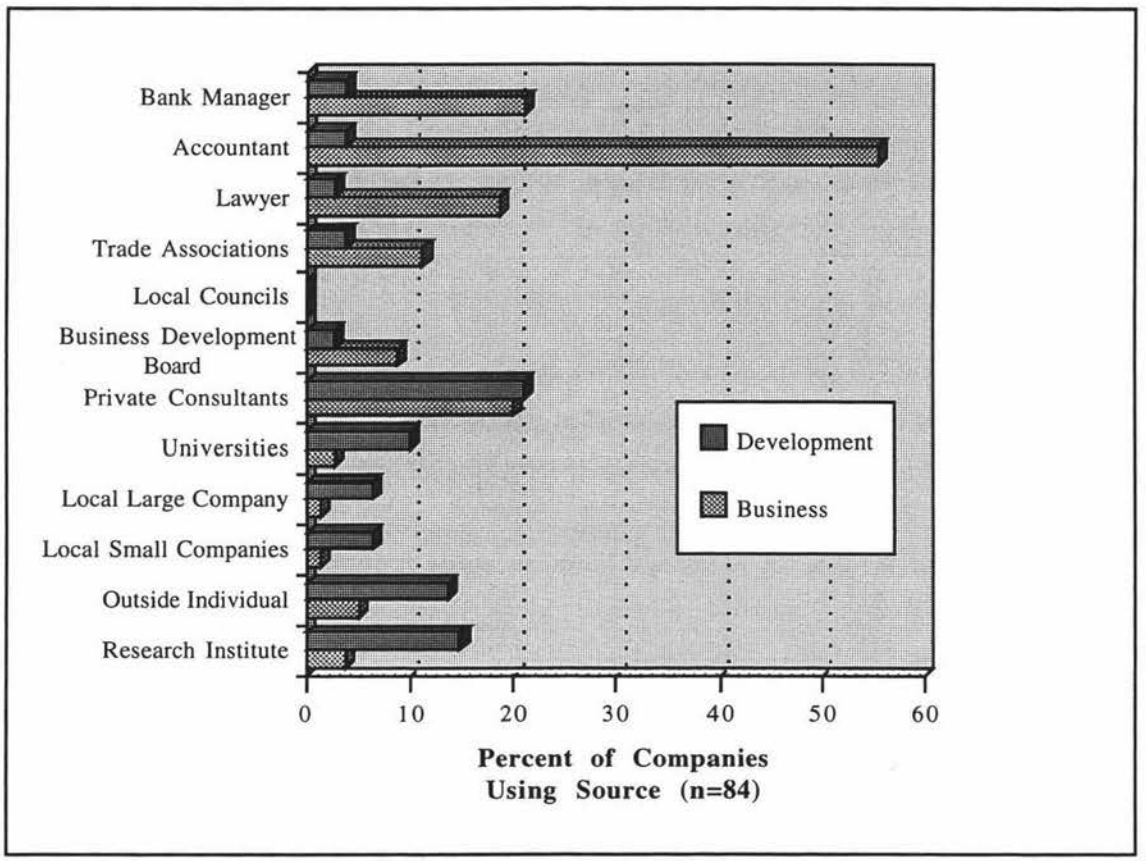
Table 9. Average Number of Techniques Used by Industry.

Industry	Average Number of Development Techniques used per Company	n
Food	20	31
Electronic	18	28
Light engineering	16	25

8.4 Sources of Advice for Business Problems and Product Development

The respondents were asked to indicate what their main sources of advice were for general business problems and for seeking Product Development advice to determine both the level of assistance and who was assisting their efforts. Figure 7 shows the results.

Figure 7 Important Sources of Advice.



For general business advice the accountant was used by 56% of the companies. In total bank managers, accountants, and lawyers were used to answer 64% of all general business problems. **Of the Product Development sources of advice, private consultants were used by 21% of companies and combined with the number of outside individuals made up 39% of all Product Development sources of advice.** Healy (1987) in surveying both large and small manufacturing businesses found the use of R&D sources to be much lower, ie.

consultants, 5%; research institutes, 4%; and universities, 1%. This study would tend to suggest that these sources were used more frequently in conducting Product Development by small companies or that since this earlier study, companies have become more extensive users of sources of advice.

Overall, companies were seeking advice when conducting or pursuing Product Development projects. Although the level of use of universities, trade associations, and business development boards were low, they were significant. Research institutes were used by 15% of companies and universities by 10% of companies. In the need to obtain technical knowledge or assistance, small companies were willing to seek advice from large institutions. It was also found that accountants, lawyers, and bank managers were seldom used for assisting Product Development. The professions these types of people are involved in tend to be risk adverse, quite in contrast to the needs of creative endeavours, however incorporating these people during Product Development should be promoted as a means to evaluate the financial merits of the project and reduce business risk.

The low level of assistance of other companies for Product Development activities or problems suggested low levels of company networking in New Zealand. This could be due to management attitudes about confidentiality and lack of inter-company information systems.

Overall, companies within the four industries used a mean of 2.5 sources of business and Product Development advice.

Finally, the respondents were asked whether they thought their Product Development endeavours were adequate and whether they would welcome more advice and assistance for Product Development if it was available at a reasonable rate. **55% of companies were happy with the way they presently developed their new products.** One could assume from this that their products were therefore successful and the companies were doing well, unless the respondent set very low expectation levels. Still, however, just under half of the companies did not believe their development attempts were adequate - a high rate!

61% of companies said that they would welcome more advice for conducting Product Development that was readily available and at a reasonable cost. Many small companies want to improve their development efforts or obtain relevant assistance. It could

be possible, given the above low usage levels of advice just described, that current sources of advice are either unobtainable or too expensive for the small company. Product Development advice targeted at small companies could possibly find a large market in the small business community.

8.5 Summary of Product Development Techniques

The research undertaken to investigate the techniques used within Product Development in New Zealand small manufacturing companies demonstrated that:

- Small company managers played an important role in the generation of new product ideas for the company. Despite the managers key role, small companies used a wide range of sources from not only inside the company but also from external sources. The techniques these small companies used indicated informal and reactive attitudes to idea generation.

- The individual techniques used within the Product Development process were non-complex, particularly for the more intangible disciplines such as market research and financial assessments. The use of these simple and easy-to-use techniques makes the quality of the incoming information to the development process questionable.

- Very few sources of advice were used for help with Product Development problems. Those companies using external advice sources most often relied on private consultants for Product Development advice but seldom used universities, Business Development Boards, or research institutes.

- In comparison with overseas practice, New Zealand small manufacturing companies use the same top techniques as do their Spanish counterparts and Canadian large companies. Generally, New Zealand companies tend to be more aligned to Spanish companies in terms of usage levels and sophistication of the techniques, although Spanish companies demonstrate greater use of these techniques in many areas.

9.0 THE MANAGEMENT OF PRODUCT DEVELOPMENT

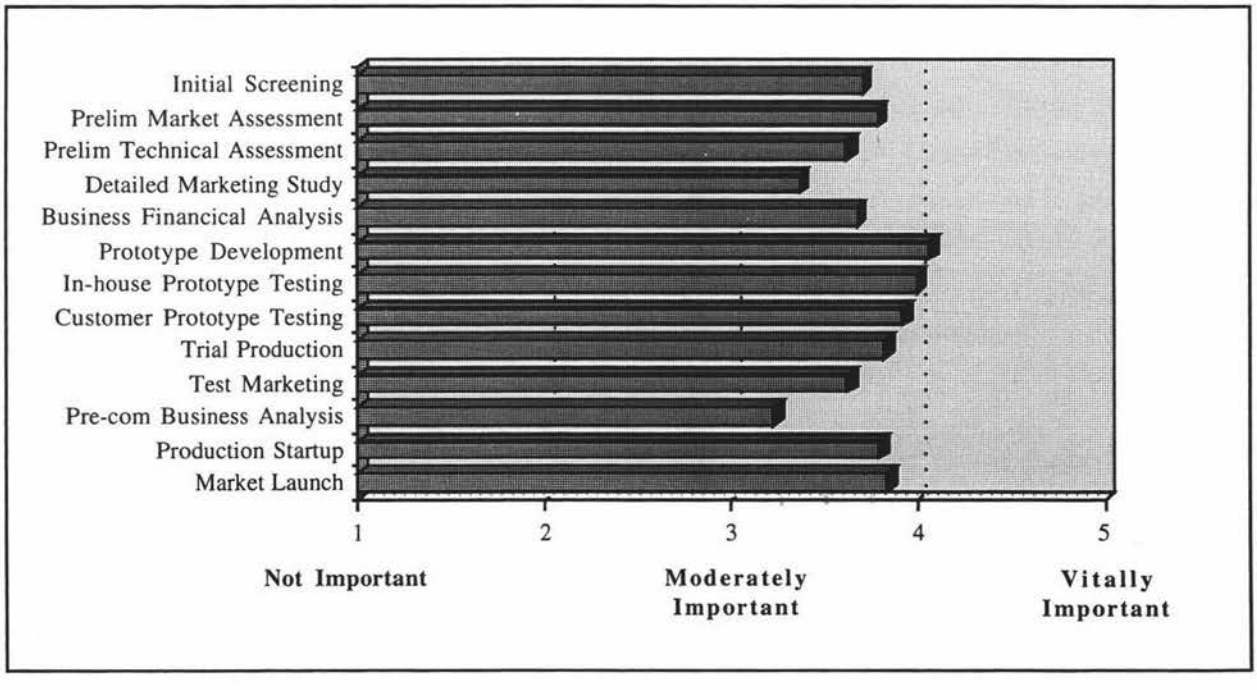
Previous research showed that company management played an important role in Product Development in terms of establishing resources and an environment for effective Product Development. This section reports on New Zealand's small company manager's perceptions of Product Development including their attitudes to the stages in the Product Development process, to key environmental factors, and the company's approach to the organisation of the Product Development function.

9.1 Managers' Perceptions of the Stages in the Product Development Process

Although the use of the stages by the companies had been determined, it was considered important to assess managements perceived relevance of the stages of Product Development to New Zealand small manufacturing companies.

The managers were asked how relevant each of the thirteen stages of the Product Development process were to developing new products in small companies. This was done on a 5-pt scale of importance and the results are shown in Figure 8.

Figure 8 Managers Perceptions of the Relevance of the Stages



All stages in the Product Development process were rated between moderately important and very important which suggested that the managers believed that all of these Product Development stages were relevant to their use in their small companies.

The activities which were regarded as being of least importance to small companies were the detailed market study and the pre-commercialisation analysis. These activities were the same as those least frequently used by the small companies. The activities believed to be the most important were prototype development and the activities of in-house testing and consumer testing of the prototype. During development of a new product the importance of constructing a prototype and testing it to ensure its applicability to the company and the market is obvious, and this is recognised as such by the company managers. It would appear that managers perceived the most important activities of the Product Development process to be those that involved the physical development of the product. It is much easier to believe in the importance of something that you can see and touch, to the detriment of the more intangible activities.

The relevance of the different stages to the managers (Figure 8) was similar to the use of the stages by the companies (Figure 1). This confirms once again the importance of management and their experience and perceptions to the undertaking of Product Development in small companies. The least relevant stages of detailed marketing study and pre-commercialisation business analysis, although still perceived as moderately important by the managers to their Product Development efforts, were seldom used. Their exists an imparity between perception and practice; they thought the stages were important but did not undertake them. This may have resulted through a lack of knowledge of how to conduct these activities.

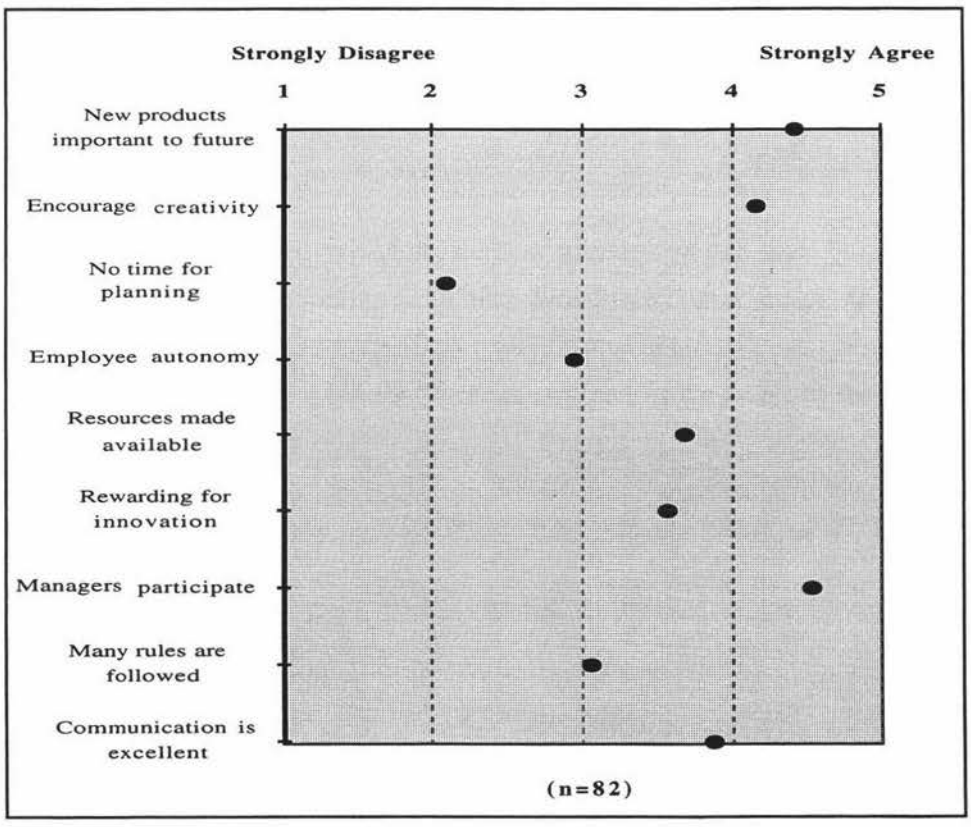
9.2 Factors Important to Product Development

Factors that are important to or encourage Product Development have been investigated for some time. It was decided to investigate these factors to see how relevant they were to the New Zealand situation and to these small companies. The investigation took two parts. The first sought managers' perceptions of how they approached certain issues, the second investigated how important cited key success factors were to their Product Development function.

9.2.1 Managers' Perceptions of Product Development Factors

Small company managers were asked the extent to which they agreed with statements relating to their company and how they personally approached Product Development. Figure 9 shows managers' agreement to statements such as 'new products are crucial to the future success of the company'.

Figure 9 Company Agreement with Product Development Factors.



It can be seen from Figure 9 that most company managers strongly agreed that developing new products was crucial to their future success, that they do actively encourage their employees to be creative, and that they actively participate in Product Development activities. Although they believed they encouraged their employees to be creative, they were not quite so forthcoming in the prescribed conditions that simulate creativity - autonomy, rewards, and resources. **The electronics industry was significantly more ($P<0.05$) encouraging to employees to be creative than the food industry.**

An indifferent attitude was shown to the use of rules and procedures in Product Development. Although managers had this indifferent attitude about rules and procedures, having set procedures was found to be highly related to the success of the companies products ($P<0.01$). This would again suggest that keeping an element of control over development efforts aids in the successful outcome of the product (de Souza, 1991). Similarly, this result provides further justification for having a structured development sequence governing development efforts.

The managers reported that they generally did have enough time to plan suggesting that new products being developed are potentially being oriented towards the future direction or position of the company, because of the direct involvement of the manager in Product Development.

A similar analysis was conducted to investigate how relevant certain cited 'success factors' were to New Zealand companies. These factors have been found from other studies to significantly impact on the success of a company's products. This analysis attempted to assess how relevant New Zealand small company managers thought these prescribed factors were to their operations in Product Development.

Figure 10 Importance of Product Development Factors.

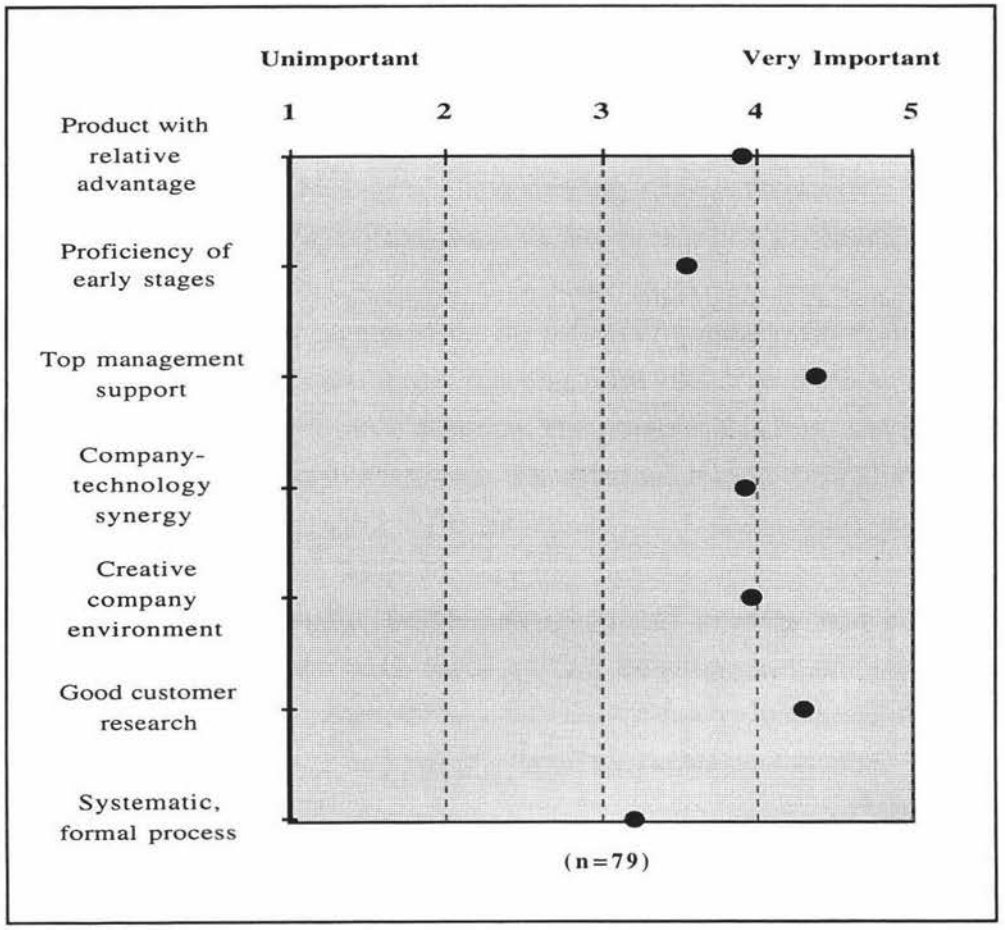


Figure 10 shows managers' perceptions of the importance of success factors. **Most of the factors were believed by these small company managers to be very important to their Product Development efforts. Top managers support and commitment, and good customer research and marketing were the two most important factors.** Once again a strong recognition of customer input into the development process was recognised. It would appear that small companies are relatively more advanced in this orientation than larger companies. This could be explained through the use of niche strategies by small companies where a customer orientation is a necessity in order to be aware of specific needs and changing wants.

Interestingly, a systematic, formal development process was only moderately important for small companies. It is possible that managers of small companies do not recognise the development of a new product as a total process, but believe that it occurs sporadically and informally. If it occurs in this fashion and there is a concentration on the physical development of the product, then a systematic process would not be perceived by the managers as being so necessary. Similarly, if managers believe they are 'close to the action', with a direct involvement in development, then they may see little reason to have a structured process.

Cooper and Kleinschmidt (1987) suggested that the factors of 'product with a relative advantage' and 'proficiency of early development stages' were the most vital in determining the success of a product and as such should receive much attention. The results of this study suggest that small company managers perceive these two factors as important and relevant to their Product Development efforts.

The importance of a systematic, formal development process was correlated to having many rules and procedures for Product Development ($P<0.05$). This may suggest that more structured companies, or ones with more effective management practices, more readily appreciate the importance of employing a Product Development process.

9.2.2 Factor Analysis

In order to assess the merits of the factors on the ability of the company to create an environment conducive to effective Product Development, a factor analysis was conducted on the above factors. A factor analysis is used to group related factors so that the underlying issues that influence the situation can be determined. Statistical analysis software 'SPSS for the Mac' was used to conduct the factor analysis. The analysis used a varimax rotation with communality values greater than 0.5. The five factors all had eigenvalues greater than 1.0, and together explained 60% of the variation. The factor analysis revealed five factors that suggest the main important influences affecting the encouragement and operation of Product Development in the small company, as shown in Table 10. These factors were found to be the conditions or inputs that are both relevant and important to small company efforts.

Table 10 Factor Analysis.

Variable	Factor 1	2	3	4	5
Too busy to plan	-.86				
Importance to future	.58				
Make own decisions		.84			
Resources available		.66			
Creative environment		.62			
Participation by management			.84		
Company communication			.72		
Top management support			.50		
Systematic process				.82	
Rules and procedures				.63	
Customer research				.57	
Technological fit					.81
Proficiency of early stages					.55

The first factor, Factor 1, was found to have strong loadings for 'managers have time to plan', and 'the importance of developing new products to the future of the company' suggests that this factor affecting Product Development could be described **'a future oriented company'**. A company that has a greater emphasis on the future direction of the company, and a more strategic approach, would be in a better position to direct future Product Development efforts.

Factor 2 was made up of 'the ability of employees to make their own decisions', 'the manager makes resources freely available to people working in Product Development', and 'encouraging a supportive and creative environment for Product Development'. This is analogous to de Souza's (1991) **'innovation facilitating environment'** where people are given resources, autonomy, and encouragement in the undertaking of innovation.

'The involvement of management in the Product Development activities of the company' is clearly distinguishable from the three variables that construct Factor 3. These were 'the active participation by management in development', 'excellent communication between the

manager and employees within the company', and 'top management support and commitment'. The crucial role of top management involvement in influencing the workings of Product Development have been cited in many previous works. This is no different for conducting Product Development in New Zealand's small manufacturing sector.

Factor 4, was made up of 'a systematic, formal development process', 'many rules and procedures are followed in development', and 'good customer research and marketing'. This factor could possibly be explained as '**control of Product Development activities**'. There exists the need to encourage creativity but at the same time to provide an element of control over the development activities to ensure they achieve goals and meet deadlines. De Souza (1991) made similar suggestions, quoting in her discussion Badaway (1986) "balance the need for creative freedom and the necessity for structure". Balancing this mix remains a development problem for small companies, particularly since a structured development process and rules and procedures are only seen as being moderately important in small company development efforts.

Finally, the last factor, Factor 5, made up of 'product fit with company technology' and 'proficiency of early development activities', could be the '**ability to carry out activities**'.

These factors generally describe the approach managers should take in controlling and influencing the Product Development effort and are similar to those suggested by the literature. Managers should have a strategic orientation to Product Development, provide adequate resources and a supportive creative environment, be directly involved and provide a balanced approach to their Product Development efforts with an element of control. Although managers do participate in Product Development and thus exercise an element of control, small companies do not appear to promote the structures and process that provide this adequate control of Product Development.

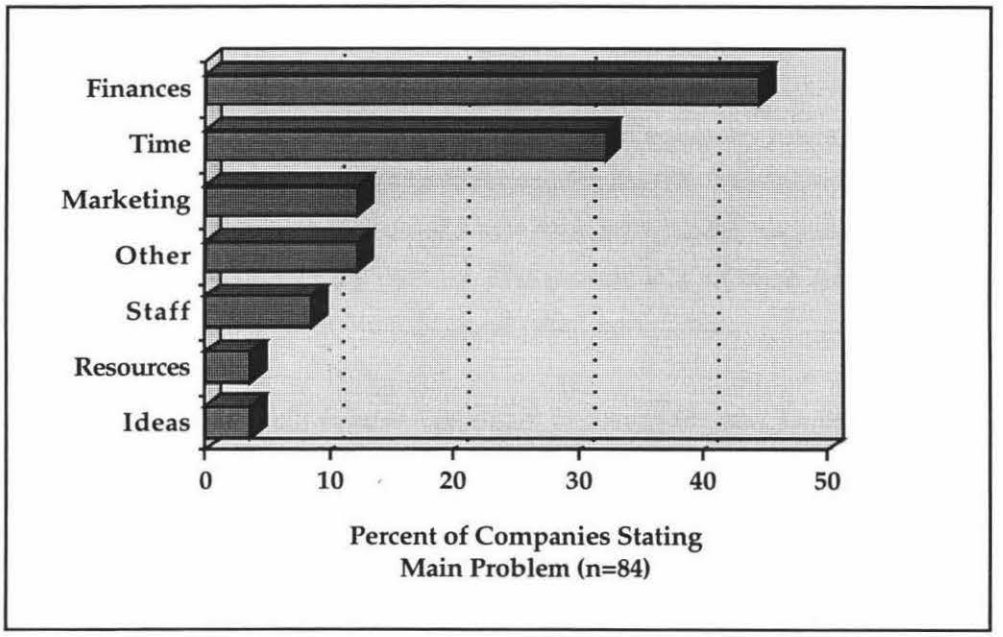
Endeavours by small company managers to create these conditions and implement these practices within their own companies should theoretically encourage the undertaking and outcome of Product Development. The majority of these factors influencing Product Development in small companies depends either directly or indirectly on the manager, in terms of personal involvement, strategies, the company environment, and human relations management.

9.3 Problems in Conducting Product Development.

The previous section analysed the factors that encourage the undertaking of Product Development within companies. This section investigated which factors were the main problems experienced in undertaking Product Development.

The companies were asked to list the main problems that they experienced in attempting Product Development, as shown in Figure 11.

Figure 11 Problems in Product Development



It can be seen that the main problems small companies experienced when conducting Product Development were financial and time restrictions. MacDonald and Mitchell (1987) determined that a shortage of ideas and a lack of skilled staff were impediments to conducting R&D in New Zealand companies. What is required to assist in the undertaking of Product Development within these small companies is a way in which these main barriers to development can be overcome. Attempts have been made to provide government funding through organisations such as the Business Development Boards and the Technology for Business Growth Scheme but they appear to be poorly utilised (see Figure 7). This may occur because of lack of knowledge of these schemes, difficulty in accessing them, or are considered

inappropriate. Similarly, the lack of a venture capital industry and the now risk-adverse nature of banks leaves little solution for the small company but to either raise the money themselves or not undertake the development project. It would also appear necessary for small companies to have more general functional staff so that more people can be freed-up to work on Product Development.

Since managers and staff have little time to conduct Product Development it would appear necessary to give small companies access to advice or people skilled in this discipline. Small business centres tailored to the needs of small businesses specifically in terms of Product Development advice could greatly assist the innovation endeavours of this most important sector of the economy. The problems faced by small companies should be investigated further to ensure unnecessary barriers do not inhibit the carrying out of Product Development.

Interestingly, marketing issues were recognised by 13% of company managers as being a problem for Product Development. Many studies have concluded that the lack of marketing input is a serious limiting factor to the introduction of a new product with the usual emphasis being placed on R&D or technical development of the product. The general lack of marketing input and skills would also appear to be the case in New Zealand small companies.

New product ideas do not appear to be a significant barrier to Product Development efforts of the small company, again supporting the idea that they are creative centres.

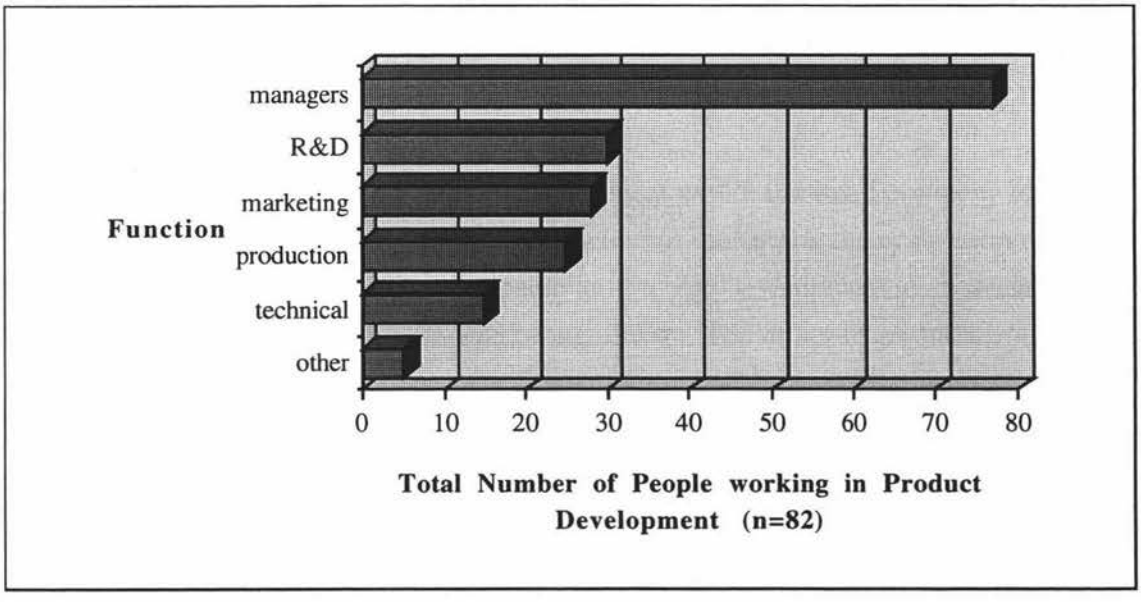
9.4 The Product Development Organisation

One of the greatest differences in terms of approaches to Product Development between overseas practice and that occurring in New Zealand small manufacturing companies, could be considered to be that of the organisation for Product Development. Numerous measures were used in an attempt to assess how Product Development was undertaken. These included the number and type of people involved in Product Development, the proportion of total staff working on Product Development, and how much time was devoted to it.

9.4.1 People Involved with Product Development

The functional areas that were involved in the Product Development activities of the small manufacturing companies are shown in Figure 12. The average number of people involved in conducting Product Development was 2 staff members, the range from 0 to 10 employees per company.

Figure 12 Functional Areas Involved in Product Development



It can be seen from Figure 12 that the small business manager was the person most often involved in conducting Product Development in the company, and this was true for 77 out of the 82 small companies responding.

This has several implications. First of all, it suggests that the Product Development endeavours could possibly be directed, albeit subconsciously, by the strategic direction of the company as was suggested in the literature (Crawford, 1982). If indeed small business managers think strategically, then their direct involvement in the development activities should ensure that the products developed are compatible with the future company position. Secondly, small business managers are incredibly busy running the daily operations of the company and often spend much of their time fire-fighting. If the managers are the ones responsible for conducting Product Development then it is probable that this activity will actually receive little attention, few products will be developed, and those that do may have been hastily developed, due to the lack of time available to managers. The involvement of top management in the Product Development function was cited in the literature as being very important to the development of successful new products (Booz-Allen and Hamilton, 1982). It would appear that in small companies the involvement of management in Product Development occurs by default due to the lack of other available staff.

The average number of people involved in Product Development in the small companies throughout the three industries was 2.1 people; the electronics industry having the highest average of 2.5, light engineering 2.1, and food having the lowest at 1.9 people.

An average of 2 people conducting Product Development within the small company is a low number in relation to prescribed organisational structure of multidisciplinary development teams (Andreasen and Hein, 1987) where it is typical to have a core development team made up of people from the functions of R&D, production, marketing, design. The utility of multidisciplined development teams would appear to be quite irrelevant to small businesses given the resource-lacking nature of small business. Time dictates that people cannot be available to concentrate on Product Development in small companies. This is not to say, however, that integrated development does not occur. Rather than people being part of a formal structure, ie. a development team, two main people are possibly involved in Product Development but when required other employees are freely asked for assistance and advice.

Table 11 shows the break-down of the number of people involved in conducting Product Development by the different company size ranges.

Table 11 Number of People Involved in Product Development by Company Size

Company Size	Mean Number of People	n (total=79)
0 - 10	1.4	30
11 - 20	2.2	28
21 - 30	2.6	9
31 - 40	4.0	8
41 - 50	3.0	4

The number of people involved in carrying out Product Development was found to be significantly correlated to the time devoted to Product Development ($P \leq 0.05$). The number of people involved in Product Development was also related to the completeness of the Product Development process ($P \leq 0.05$). It would seem that a greater number of people involved in Product Development allows more stages of the Product Development process to be completed.

9.4.2 Product Development Intensity

The proportion of company staff who work in R&D, a measure used by Senchack (1981), provides an assessment of the level of employee commitment to R&D. There were only 30 recognised R&D staff in the whole survey out of a total employee population of 1380. This resulted in a proportion, or R&D Intensity, of only 2.2%.

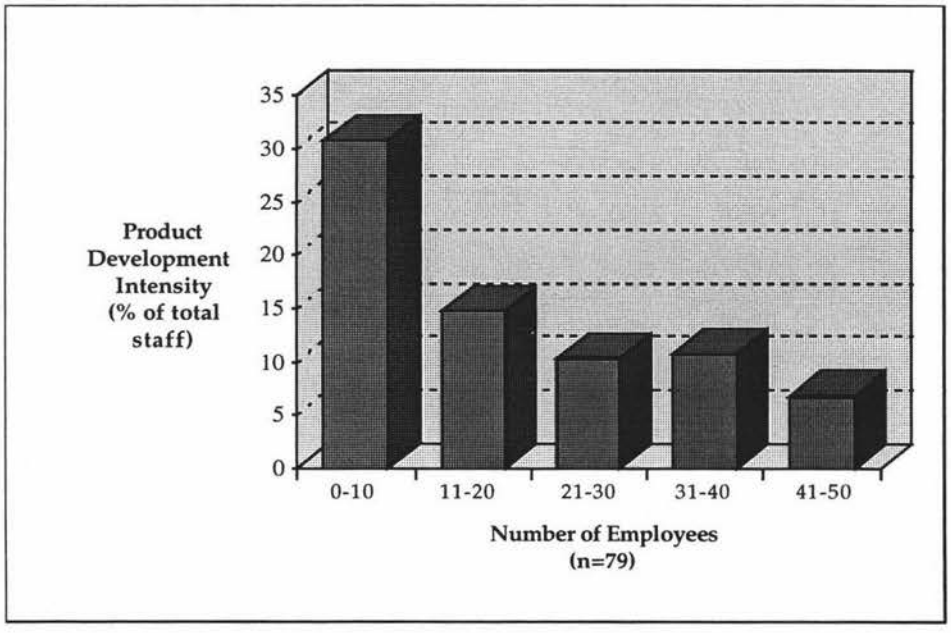
In Healy's (1987) study into R&D in the New Zealand manufacturing industry, he determined that in small-medium companies (between 20 and 100 employees), only 200 people were reported to be involved in research and development out of a total population of 12,226 employees. This resulted in an R&D intensity of 1.6% ,which was similar to the results of this study (2.2%). If we compare these figures with those of Senchack, for small (under 75 employees) American companies, where

the average R&D intensity was 9.2%, then this suggests that there are few people working in research and development in this country. Four times the present number of R&D people would have to be educated and employed to have a corresponding level to the United States!

If the analysis includes all those people involved in conducting Product Development however, the Product Development Intensity increases to 12.3% which may be a more accurate level given the informality of this activity. This figure may well be over-stated, however, because many of the Product Development employees may not work in this activity full time.

R&D is viewed by companies as a very specific and formal activity involving scientific or technological inputs. This study has for the first time looked at the total process for developing new products, which includes not only the specific discipline of R&D, but many other company functions. Few companies have R&D dedicated staff but most have several staff from other functional areas involved in doing Product Development. This may have affected previous studies where the authors were attempting to investigate issues relating to products and their development but incorrectly calling this discipline R&D which has different connotations to the less formal and more multidisciplined activity of Product Development.

Figure 13 **Product Development Intensity by Company Size**

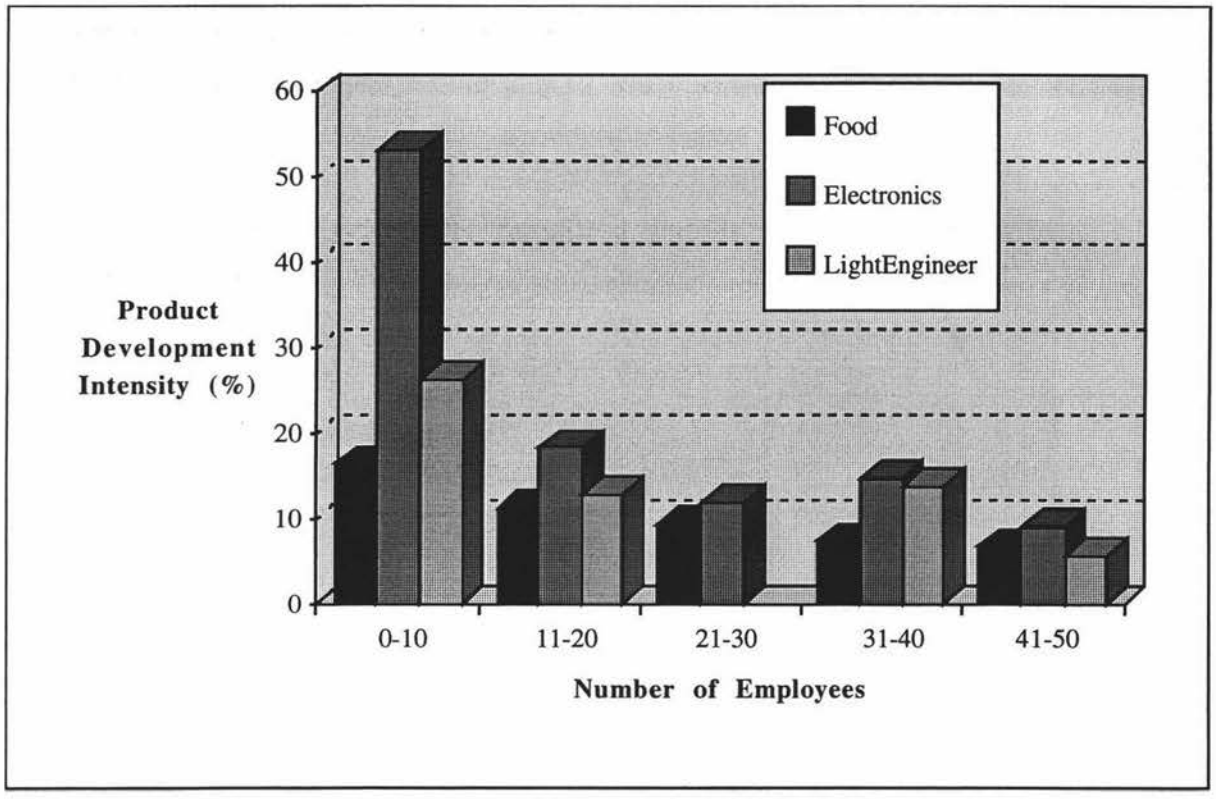


An analysis of the Product Development Intensity versus the size of the companies revealed that relatively more staff (31%) were involved in Product Development in companies with 0 to 10 employees and that this quickly decreased as the size of the companies increased (down to 7% for companies employing 40 to 50 staff). These results, shown in Figure 13, are very similar, although slightly higher in this survey, to those found by Senchack (1981). Senchack explained this result by once again suggesting that part-time staff involved in Product Development were overestimating the results, and that a minimum required level is needed to maintain a formal R&D activity. Thus, if it typically takes two people to develop new products then the proportion is naturally going to be higher for a smaller sized company, suggesting that small companies are entrepreneurial centres, relatively.

Overall, electronics companies had significantly more employees involved in conducting Product Development at an average Product Development Intensity of 29% of employees ($P \leq 0.05$), than light engineering with 17.8%, and food companies with 12.2%.

Breaking these results down further into Product Development Intensity by industry and company size (Figure 14), it is evident that very small electronics companies are greatly impacting on these results with an average of half the company employees working in Product Development. Small electronics companies are heavily involved in Product Development which supports the hypothesis that companies in this industry commit proportionately more to Product Development.

Figure 14 Product Development Intensity by Company Size and Industry.

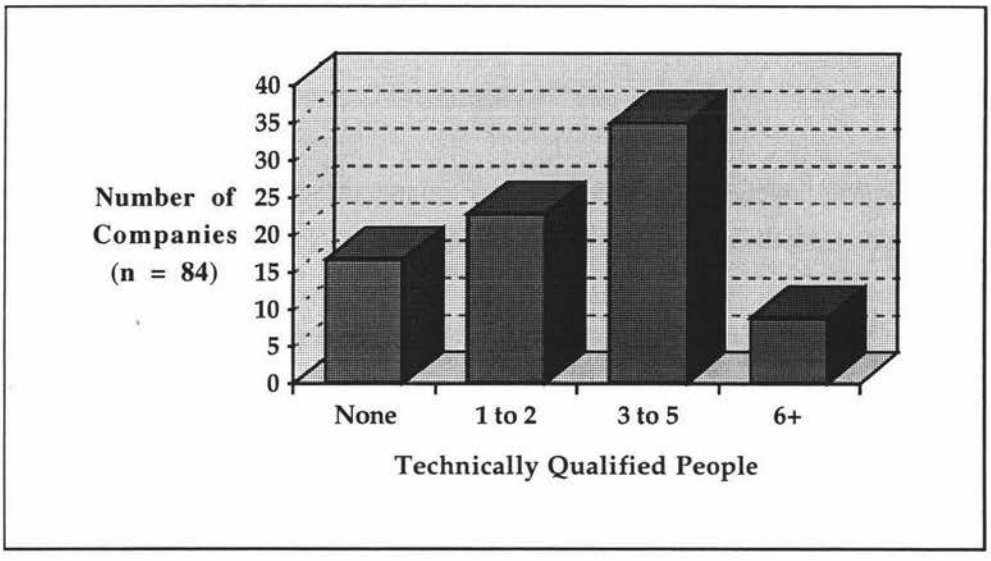


Very small electronics companies have significantly more employees involved in Product Development relative to all other company sizes and other industries at around 53% of employees ($P \leq 0.05$).

9.4.3 Qualified Employees

It could be argued that the ability of a company to advance and to try new endeavours is largely determined by the combined skills of its staff. Thus, a measure of the professional competence of the companies was undertaken and is displayed in Figure 15.

Figure 15 **Technically Qualified People in Small Companies.**



A large proportion of companies (42%) had between 3 and 5 technically or university trained employees within their companies; the average at around 3. This figure, when compared with the average size of the company (16 employees) indicates that a reasonable proportion of the company population were relatively highly skilled. This average figure of 3 employees technically or university trained for an average small company size of 16 employees (19%) is much greater than was found by Healy (1987); 25 technically qualified people per 1000 employees (2.5%).

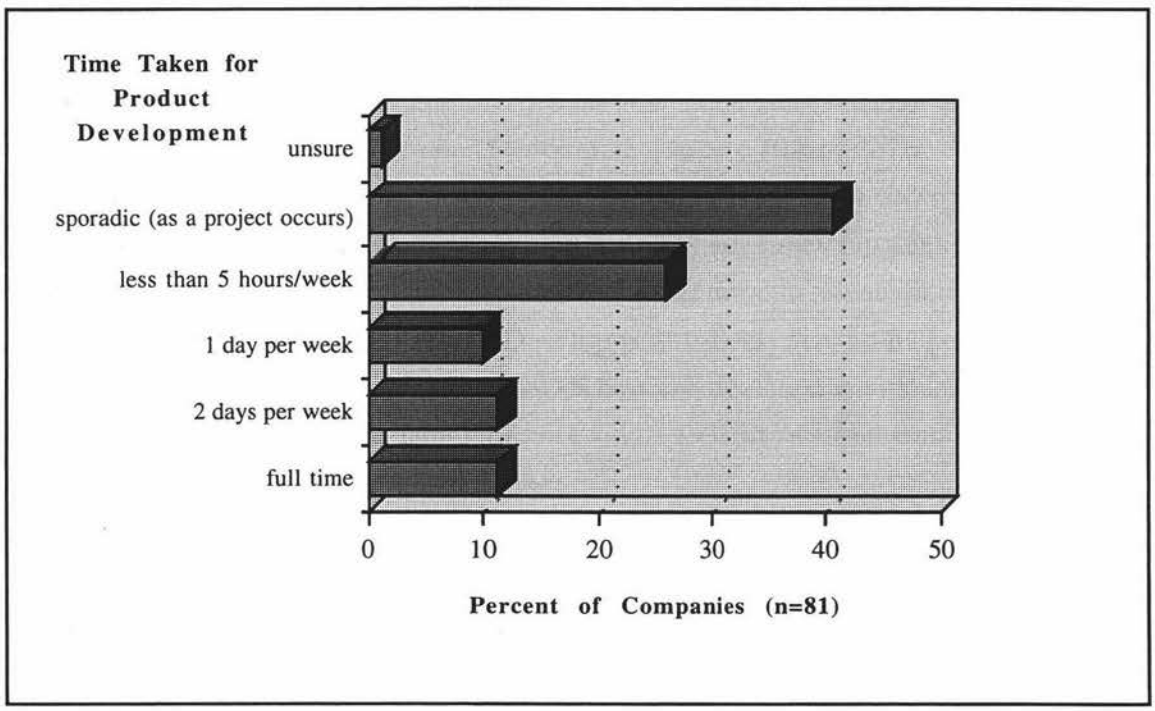
The company managers were asked to state their personal highest qualification. 29% of the company managers had a university degree, 38% had a trade certificate or equivalent, and 18% only had school certificate or less. It could be considered, therefore, since two-thirds of these small company managers were tertiary or trade qualified, that New Zealand small company management is quite highly trained. Managers qualifications were related to participation in PD.

The educational background of the manager was investigated in relation to the output of Product Development in a previous study although no significant relationship was determined (Pavia, 1991). It could be suggested that the higher level of business knowledge or expertise in their field that the manager has, the more accurate decisions will be. Many company managers would no doubt dispute this, claiming experience is the key managerial tool. What was not evident, however, was the extent this educational background benefits their general business management skills or more specifically, their Product Development management skills.

9.4.4 Time Devoted to Product Development

Another measure concerned with the managers' approach to Product Development was the amount of time devoted to it per week. Figure 16 shows the time companies dedicated to Product Development by these small companies.

Figure 16 **Time Spent on Conducting Product Development**



Small companies actually spend very little time specifically devoted to Product Development, on average 9 hours per week with a median time of less than 5 hours. Food companies spent about 4 hours per week, whereas electronics and light engineering spent about 6 hours per week on developing new products. Only 11% of companies actually conducted research and development or Product Development on a full time basis. This is quite a low level considering the importance awarded to new products and innovation by the company managers.

The size of the company was found to be related to the time devoted to Product Development ($P \leq 0.05$), suggesting that larger companies, with greater available resources, spend more time conducting Product Development.

The time devoted to conducting Product Development was found to be significantly related to how proactively the company generated new product ideas ($P \leq 0.05$) and the innovative success of products developed ($P \leq 0.05$).

The implications of spending time on Product Development are obvious! If Product Development is to receive the commitment and attention it requires to be effective and efficient, time and resources must be devoted to it. The fact of the matter is, however, that small businesses are extremely strapped for resources, particularly man-power and time, which makes it very difficult for such an intangible activity as Product Development to be conducted. The very low effort in terms of time committed to Product Development would suggest that in order to develop and introduce new products within a reasonable time period, many time-consuming activities of Product Development would have to be overlooked either through oversight or through some risk/benefit decision. Conducting Product Development for only five hours per week suggests that their efforts are very disjointed with long periods between development sessions. This low time input also has implications for the length of the Product Development projects and one of the fundamental competitive issues, time to market.

9.5 Company Planning

A measure of the extent of corporate planning conducted in small companies was obtained. **It was found that most companies (56%) planned for the medium term (1 and 2 years), 22% planned only for the immediate future (1-3 months) and 20%, planned for the long-term (3 to 5 years). All industries displayed the same levels of planning on average.** Only two companies stated they did not have enough time to plan or that they do not need to plan.

The planning conducted by a company and its managers determines largely the extent to which its future can be predicted and its future position achieved. Product Development can then be oriented and directed to ensure its future products are compatible with its future position and policy. Thus, Product Development must be connected to company strategy to ensure the future expectations of the company are achieved through future products. Since most companies plan for the medium term they have some ability to direct their Product Development efforts to be compatible with this future position.

9.6 Summary of the Management of Product Development

The following summarise the results of the attitudes and approaches of small company managers to Product Development.

- Managers' perceived all stages of the Product Development process as being important and relevant to small company Product Development practice. Management perceived the physical development of the product as being more important.

- In terms of managements approach to Product Development, they recognised the need for new products, actively participated in Product Development, and encouraged a creative environment. They did not, however, place such importance on the factors that encourage people to conduct effective Product Development such as employee autonomy, resources, or rewards, and they saw little need for a formal Product Development process or rules and procedures for Product Development. A factor analysis determined that companies should have a future-oriented company, provide an innovation facilitating environment, involve management in Product Development, control development activities, and conduct Product Development activities effectively.

- These small companies had little finances or time in order to conduct Product Development. On average companies spent 9 hours per week conducting Product Development, the median time being less than 5 hours per week.

- Managers were involved in conducting Product Development in almost all small companies and did so with one other person, typically from either R&D, marketing or production. Typically, 3 people in these small companies were technically trained and the majority of managers were university or trade qualified.

- The proportion of total company staff working in Product Development was far greater in the very small company which then decreased as the company size increased. Electronics companies devoted the greatest proportion of staff to Product Development.

10.0 OUTCOME OF COMPANIES PRODUCT DEVELOPMENT EFFORTS

Numerous measures were used to assess the success of the company and its products in order to evaluate the results of the companies' Product Development efforts and the products they introduced. Many of these measures were subjective, dependant on the perceptions of the company managers. These in turn were dependant very much on the experiences of the managers and their industry norms.

10.1 Frequency of Innovation

The respondents were asked to record the number of new products they typically launched or introduced to the market per year. The average number was found to be 4.2 products per year. Table 12 shows the results from the four industries.

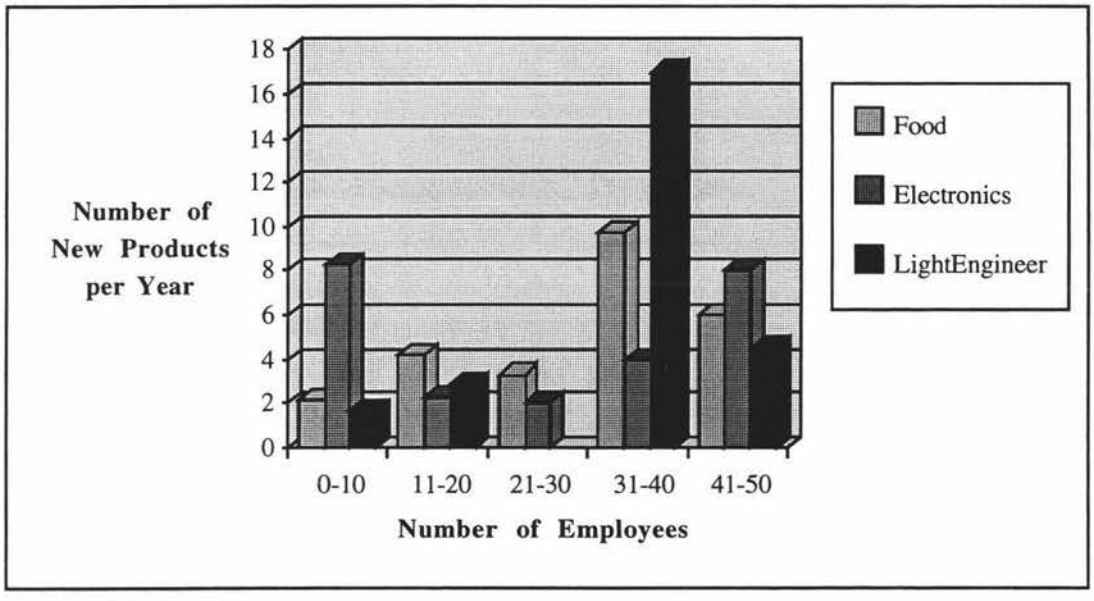
Table 12 Frequency of Introduced Products by Industry.

Industry	Mean Number of products per year	Median Number	Range	n
Food	4.2	3	1 - 30	29
Electronics	4.6	2	1 - 30	27
Light engineering	3.8	2	1 - 50	23

The small manufacturing companies introduced about four new products to the market per year. Only two people undertook Product Development efforts and these were typically for five hours per week. This results in a total annual Product Development time of 520 hours. Dividing this by four new products per year and this suggests that it typically takes New Zealand small manufacturing companies 140 man hours to develop a new product. Although the results cannot be directly compared, Page (1993) reported that it took on average 2.95 years for American companies to develop more innovative types of products, also using a multidisciplinary team. Although the products produced by New Zealand small companies may not necessarily be as advanced or as complicated as those produced by large American companies, this result suggests that local companies develop new products very rapidly.

Figure 17 investigates the levels of product introduction over the range of company sizes.

Figure 17 **Frequency of New Products by Company Size and Industry**



Companies between the sizes of 30 to 40 employees were the most prolific at producing new products, on average 10 per year, and light engineering companies introduced by far the most new products in this company size range.

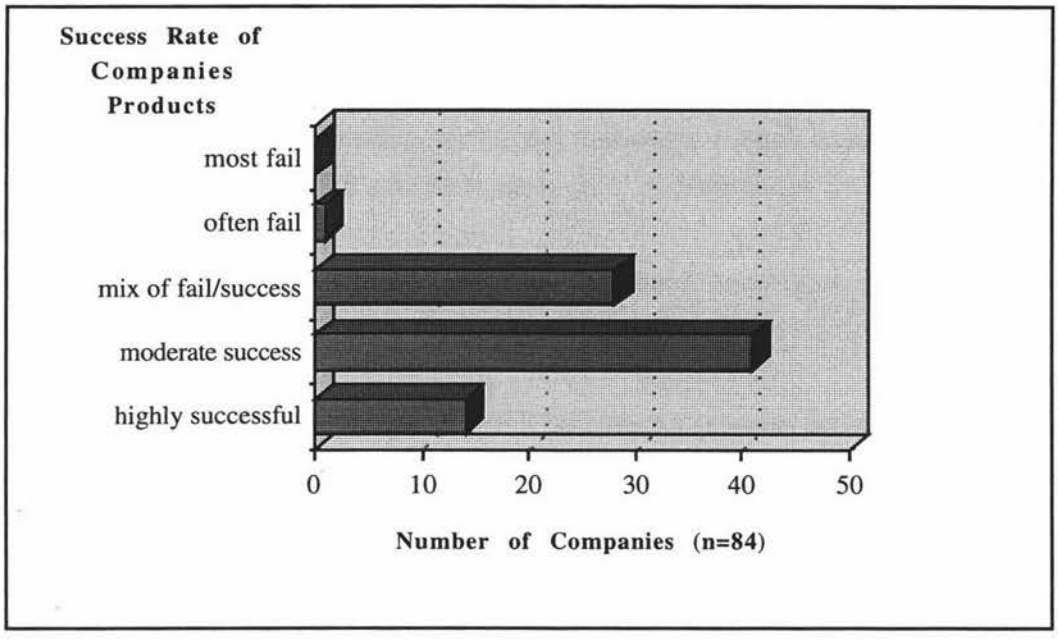
Small companies below 30-40 employees (excluding very small electronics companies) were capable of introducing only a few new products per year. However this average increased when they reached the size of between 30 to 40 employees. This sized company appears to contain a critical mass of resources to effectively develop and introduce numerous new products, particularly for light engineering companies. A further increase in size results in the number of new products dropping off again. It is possible that company sizes below 30 employees do not have the resources or the structures to effectively develop or introduce new products, even though they have many new product ideas. Similarly, companies above 40 employees may have too much structure, too little effective control, or too few new ideas - a result of management not being able to adjust to the new conditions or requirements of the larger firm.

The frequency of new products was correlated to the number of people and a marketing person in Product Development, and resources for Development).

10.2 Success of Majority of Company's New Products

On a 5-pt scale companies stated how successful the majority of their new products had been. They were asked to assess these products against the expectations they had for the products before they were launched and against the competitors' products. Figure 18 shows how successful the surveyed companies had been.

Figure 18 **Success of Companies' Products**



The outcomes of companies' products were mixed with 27% of companies experiencing a mix of failures and success, and only 14% experiencing a high degree of success resulting from their Product Development efforts.

All industries products were on average moderately successful in the marketplace.

The success of companies' products was correlated to having 'rules and procedures in development', 'the innovation type of the products typically developed' ($P<0.05$), and the 'success of the last product developed' ($P<0.01$).

The results above suggest that having rules and procedures for Product Development and thus giving it more control and direction has the effect of actually increasing the success of the company's products although management had an indifferent attitude to rules and procedures. Similarly, if the product developed is more innovative, ie. newer to the company and the market, it will also be more successful, at least in the opinions of these small company managers. This is a significant result and supports the theory that increased product innovativeness increases the success of the products. Cooper and Kleinschmidt (1991) studied the effects of product innovativeness on the outcome of products. They found a U-shaped relationship between product success and degree of product innovativeness suggesting that non-innovative products are successful due to closeness to existing operations and knowledge, while high-innovative products were successful due to their 'product advantage' factor. Moderately-innovative products, however, fail to achieve the same results because they are not innovative enough to have a differential advantage but too different from usual operation to gain from company synergy or experience.

The result of the last product introduced may have influenced the managers' opinions of the majority of their products.

10.3 Contribution of New Products to Company Growth Rate

In order to obtain a measure of financial success of these companies, they were asked to indicate how great their company's sales growth rate had been in the past three years. **It was found that the food industry had experienced the highest rate of sales growth but this was only moderately high. The remaining industries averaged only moderate growth.**

They were also asked to indicate the percentage that new products had contributed to this growth rate in order to obtain a measure of growth from new products as opposed to new markets, economic conditions, or any other influence other than the introduction of new products. **The estimate by the company managers of the contribution new products had had to the growth rate of the company was greatest in the light engineering industry. On average, new products had contributed 44.7% to the companies' growth rate over the past three years in this industry. The electronics industry followed with around 40.8%, and the food industry had the lowest contribution to growth rate from new products at 32.2%.** One must remember, however, that these values were subjective estimates by company managers. The results showed that New Zealand small companies

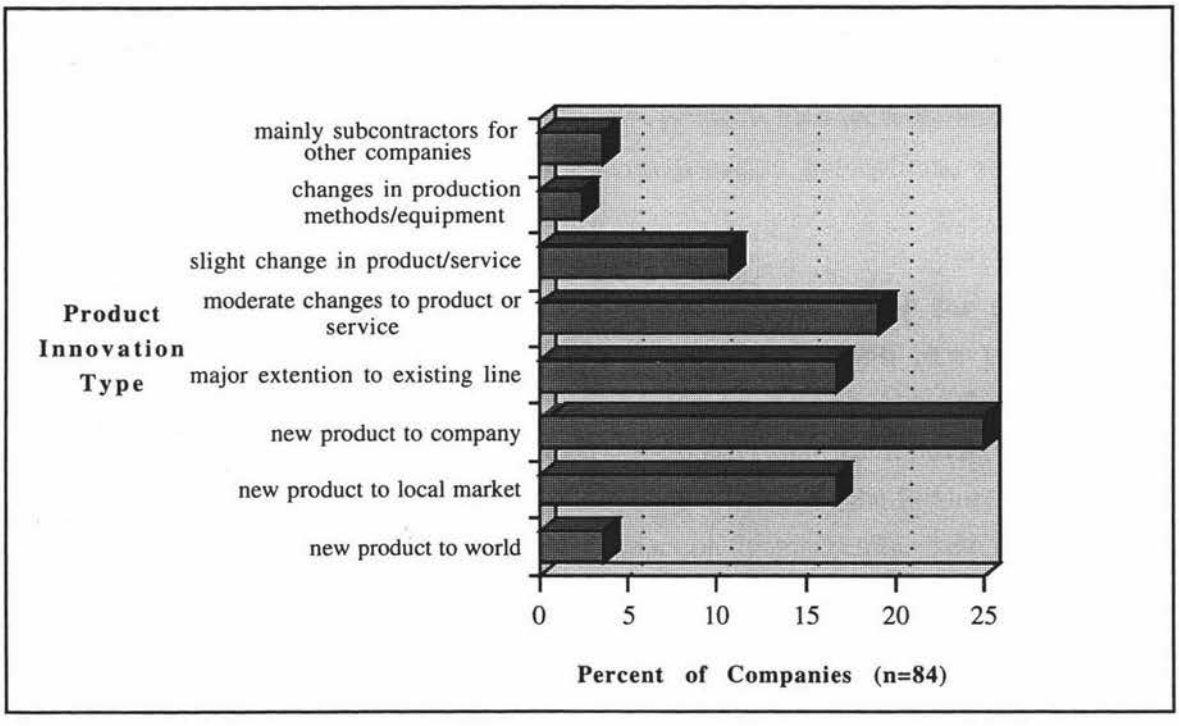
relied quite heavily on new products for growth and thus the importance of Product Development, and the continuous development and introduction of new products, is obvious.

Similar measures have been analysed in other studies. Mahajan and Wind (1992), found that 25% of sales had come from products introduced in the last three years for American Fortune 500 companies.

10.4 Innovation Type

This measure investigated an assessment of the degree of innovativeness that was typically displayed in the companies' products or services associated with the product, as shown in Figure 19.

Figure 19 **Innovativeness of Companies' Products**



It was found that the majority of the managers believed that they typically developed products which either had 'moderate changes' or were 'major extensions to existing product lines'. There were 38 companies who typically developed products new to their company, the local market, or to the world, as they perceived them.

These types of product innovation are considered to be on the upper end of the innovation scale. Any product that is considered to be new to the company is thought to involve a major step, involving Product Development and substantial commitment of time and resources, and are thus more departed from incremental product improvements. More so for products developed that are new to the local market and to the world. Since these were products the companies typically introduced, these figures provided a general level of the innovativeness of New Zealand's small manufacturing companies' products, and suggest they were quite innovative. Previous studies typically found that new products are usually of the infrequent and incremental type (de Souza, 1991; Sanchez and Elola, 1991).

An analysis of the mean type of innovation over the industries suggests that light engineering companies were producing slightly more innovative products than food or electronics companies. Again, one must remember that these were based on managers' perceptions, which will vary with industry norms and managers' experiences.

The innovativeness of the product was correlated to the time for planning, the proactiveness of generating new ideas, and the contribution new products had to company growth rate, but negatively correlated to having a marketing person working in Product Development ($P \leq 0.05$). It appears that the innovativeness of the developed product was dependant on many of the early activities in the Product Development process, and the more innovative the resulting product on the marketplace, the more new products had contributed to the growth of the company. Product innovativeness appears to be a major factor for Product Development.

The increasing size of the company was negatively correlated to the innovativeness of the last product developed ($P \leq 0.01$).

10.5 Innovation/Success Score.

In an attempt to obtain a figure that described just how successful the company and its products had been and the contribution innovation had had to this success, an innovation/success score was generated. De Souza's (1991) innovation score was similar in nature and content (discussed in Section 3.3). This research used an innovation/success score made up of innovation type, success of most products developed, frequency of new products introduced, degree of growth rate, and the contribution new products had to this growth rate. The score was calculated by:

$$\text{Innovation/Success Score} = \text{type} \times \text{frequency} \times \text{success} \times \frac{(\text{growth rate} \times \text{contribution})}{100\%}$$

If a company had experienced average or moderate scores for all of the above variables, ie. had introduced few, moderately innovative new products and had experienced moderate product and company success from its Product Development efforts, it would have a innovation/success score calculated as shown by:

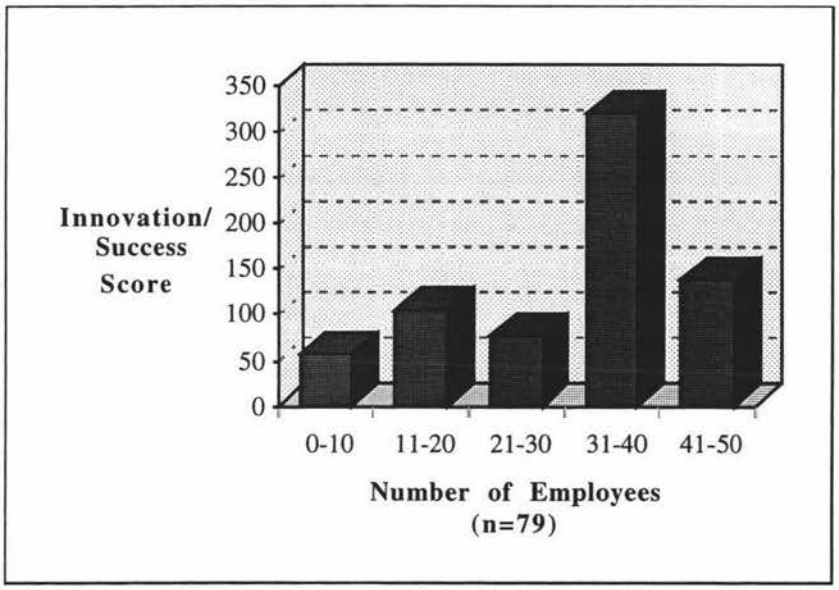
$$\text{Innovation/Success Score} = 6/8 \times 4 \text{ new products} \times 4/5 \times (4/5 \times 30\%/100)$$
$$= 115$$

It was found that the majority of companies fell well below this average figure of 115, failing to score moderately on every measure. Fifty of the 84 manufacturing companies completing this section scored lower than 100 while only 10 companies scored over 250. Therefore, while companies perceived their efforts and the results of their efforts to be quite innovative, in actual fact very few companies were actually conducting innovation, in terms of an innovative product successfully competing in the marketplace. The vast majority of companies were failing to commercialise successfully their innovative (perceived) products and achieving company growth from it.

As has been stated previously, this score was found to be correlated to the completeness of the Product Development process and the time devoted to Product Development per week ($P<0.05$). The more effort put into Product Development, the greater the success and innovativeness of the company's products.

An analysis of this index over the various company sizes is shown in Figure 20.

Figure 20 **Innovation/Success Score over Company Size**



One can see that companies between 30 and 40 employees were the most innovatively successful. Apart from companies between 20 - 30 employees, the general trend was for innovative success to increase until 40 - 50 employees where the score then decreased. Since this score includes not only how innovative these companies' products were but also the contribution innovation had had to company growth, it provided more of a indication of innovation within the company, ie. creativity through to marketplace. In this regard, it confirms companies must blend creativity with resources to effectively produce innovation.

Companies between 20 and 30 employees appeared to be ineffective at benefiting from innovation. It may be at this size that the problems of management control occurs over the increasing organisation, and the balance between creativity, resources, and control is lost.

10.6 Exporting

For the sample, 56% of companies exported. This figure appears quite high considering the small size of the companies and their obvious resource disadvantages. Of the companies that exported product, Australia (64%) was by far the most common destination, Asia (12%), Europe (12%), and the Pacific (10%), America and Japan were seldom export markets. The average level of sales exported by the small companies was 21%, but ranged from 1% to 99% of sales.

10.7 Summary of the Outcomes of Companies' Product Development Efforts

The New Zealand small manufacturing companies demonstrated only moderate results from their Product Development activities.

- The companies typically introduced 4 new products to the market per year. Light engineering companies with between 30 and 40 employees introduced the largest number of new products per year.

- Most introduced new products were moderately successful once launched and companies considered them to be moderately innovative. As a result, the companies had experienced moderate sales growth rate over the past three years, new products contributing 40% to this increase.

- An overall measure assessing the companies' outputs and the results of these efforts to the companies determined that few companies had experienced consistent benefits from their Product Development efforts. Small companies are not conducting effective Product Development or cannot successfully commercialise their new products. Companies between 30 and 40 employees had experienced a much higher innovation success rate on average as they were more experienced and had more resources to successfully commercialise their efforts.

- Several factors were found to correlate with the innovative success measures used. These were the number of people involved in Product Development, marketing people involved, the number of technical trained people in the company, the time devoted to Product Development, the innovativeness of the product, rules for and resources for Product Development, the number of stages in the Product Development process, conducting a preliminary marketing assessment and a trial production, and the success of the last product developed.

- 56% of the small companies exported, 64% of them exporting to Australia.

11.0 COMPARISONS AMONG INDUSTRIES AND PRODUCT TYPES

11.1 A Comparison Among Manufacturing Industries

Another secondary issue of investigation of this survey was a comparison of the practices of the different manufacturing-type industries of food, electronics, and light engineering. The hypothesis put forward suggested that electronics companies were possibly more innovative given the high technology field they exist in, food utilised more techniques and were more cognitive of the consumer input to Product Development, and finally, the light engineering industry was more traditional and therefore would score relatively less on many measures, particularly innovation and the level and sophistication of Product Development practice. The results largely support these suggestions.

Food companies committed little to Product Development although overall were more consistent in the results of Product Development. Food companies on average were found to utilise slightly more techniques of Product Development and clearly had a greater emphasis on conducting a trial production stages given the nature of the production processes used by food companies and the larger volumes produced. Food companies also had a higher mean level of innovative success. However, food companies were found to have the lowest Product Development Intensity of staff, the shortest amount of time for Product Development, and the lowest contribution of new products to company growth rate. Food companies displayed low levels of commitment to product development, relying on past product revenues, although they performed more Product Development techniques. Food companies recorded lower or similar scores for most Product Development output variables to the other industries but overall had a higher innovative success score indicating more consistency in the outcomes of Product Development.

Electronics companies were relatively more committed to Product Development. Electronics companies were found to use a greater level of the technical stages of the Product Development process, have a higher average number of people conducting Product Development, higher intensity of people in the company devoted to Product Development, introduce slightly more products per year, and had the highest contribution of new products to company growth rate. Electronics companies, however, had the lowest mean innovative success score. Obviously,

electronics companies were more involved with conducting Product Development, emphasising their need and appreciation for innovation and new products. High technology industries, such as electronics, commit relatively more resources to Product Development in an attempt to stay abreast of current and future technologies and the applications of these technologies. Although they attempted to introduce many new products to utilise new technological developments, they were not successful in the marketplace against the competition.

The light engineering companies were less extensive practitioners of Product Development although they perceived themselves to being more innovative. Light engineering companies used fewer stages of the Product Development process, having the lowest usage in 7 out of the 13 stages, including the lowest level of customer involvement, used the lowest number of Product Development techniques, and introduced the fewest new products per year. Surprisingly, the anticipated more traditional companies that make up the light engineering industry were found to have some innovation and Product Development measures higher than the other industries. They were found to use more sources of new product ideas and believed they were more proactive in their generation of these new ideas. Furthermore, their products were rated by these companies as being more innovative than the other industries. Although many of these results involved subjective assessment and are therefore based on the perceptions of the company managers, this industry appears to believe that they are quite innovative in their Product Development endeavours, although they show little understanding or use of Product Development.

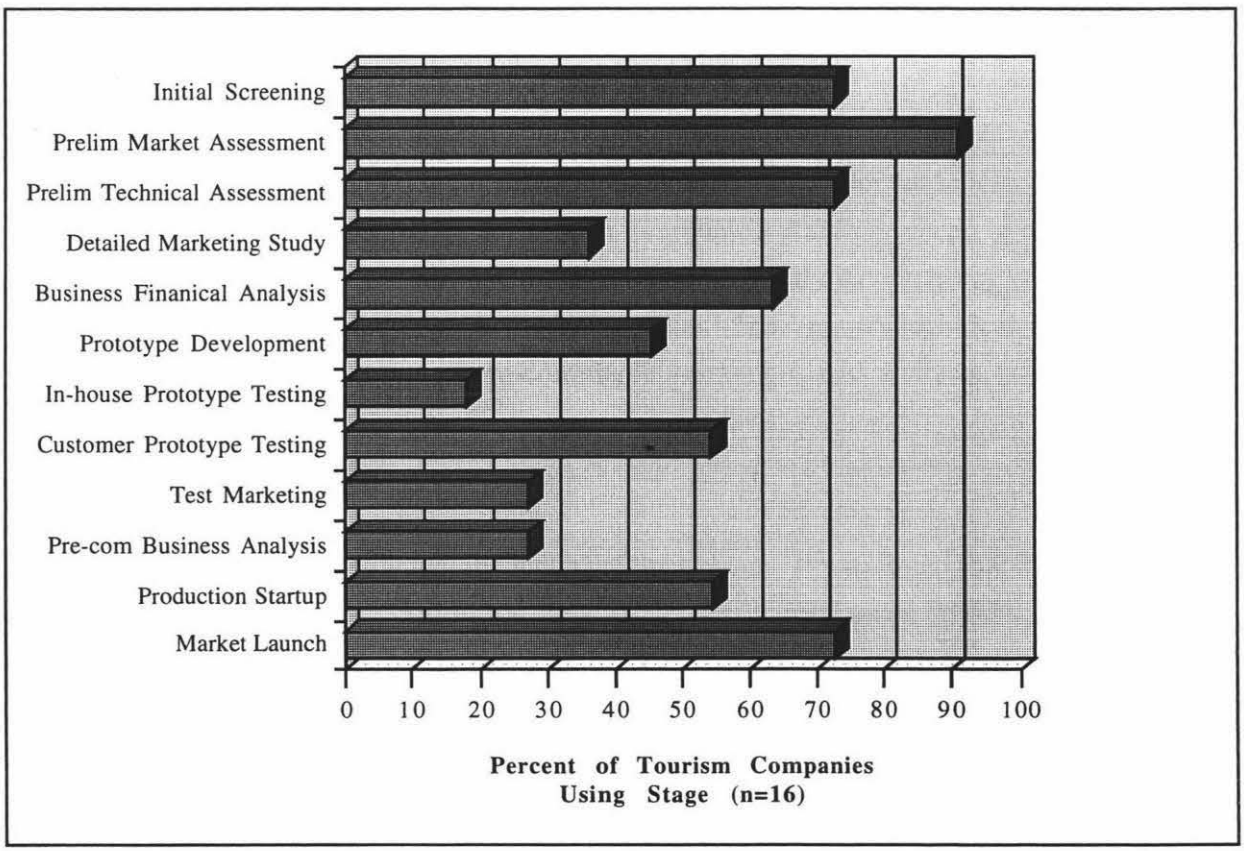
All three industry types demonstrate measures that suggest they are involved in Product Development and innovation to some degree. Electronics companies are more committed to resourcing Product Development as they attempt to utilise new technologies and new applications in a fast-paced industry. Food companies demonstrate mixed approaches to Product Development, successful but poorly resource Product Development. Finally, light engineering companies show poor Product Development practice but perceive themselves as having innovative endeavours.

11.2 The Tourism Industry

A secondary issue of this research was the comparison of a service industry with the more common manufacturing industry with regard to Product Development. It has been suggested that the development of a service product is similar to that of a manufactured product with some important differences. Easingwood (1986) suggested that the development of services differs due to the nature of services, ie. they are intangible and there is simultaneity of production and delivery, ie. the service is produced (or manufactured) at the same time as it is delivered (sold) to the customer. Hence, when you go to the theatre or deposit money at a bank, what happens at that moment of delivery, which is also the time when the service is produced, determines customer satisfaction.

The same analyses was conducted on the tourism industry as the manufacturing industries. Figure 21 shows the relative levels of usage of the Product Development process by tourism companies.

Figure 21 Product Development Stages used by Tourism Companies.



Comparing this figure to the manufacturing one, Figure 4, there can be seen some significant differences. Remembering that the activity of trial production was not thought appropriate to the tourism development, service prototype development and testing of this prototype was conducted far less in tourism companies. It would appear that this industry either does not recognise the terminology of these activities, or does not perform and test their services before they introduce them to the market. This may have something to do with the simultaneity of these products, however, one would perceive the need to test a certain venture, such as a four wheel drive trip or a white water rafting operation, to test its physical merits, particularly for customer safety reasons.

Customer testing, test marketing, and production start-up were also less frequently used by tourism companies. Although production start-up may appear unusual given the simultaneity of service production and delivery, one obviously has to get in a position to be ready to go before promoting the operation, through the purchase of equipment or gear. Two activities were conducted more often in tourism companies than manufacturing. Preliminary market assessment was used by almost all companies. It is important for these very small companies to assess their market before launching into the development of a new venture. The financial/business analysis was also used more by these companies, the size of these companies dictating its necessity.

Surprisingly, preliminary technical assessment and service launch were seen as very important to these companies. The necessity for technical assessment arises due to the nature of many tourism operations in that customers are often physically moved, more often than not in adventure or thrill type endeavours, and hence many characteristics of its technical possibility need to be assessed. Significant differences were found between tourism companies and manufacturing companies in the perceived relevance to small companies of the activities of preliminary technical assessment, prototype development and testing, and pre-commercialisation business analysis. 60% of companies conducted 7 or less activities.

The respondents were asked to divulge the nature of their clients. It was found that local people made up on average 21% of their customers, New Zealanders in total made up 60%, and overseas tourists, 40%. Overseas tourists were mainly from Europe (25%), UK (21%), and the US (18%).

It was suggested by Easingwood (1986) that the intangibility and simultaneity of services can result in large numbers of new product ideas. This research suggests that this may be so. Tourism

companies had introduced on average 6 new services since the start of their operations with the average age of the company being 11 years. It is possible to generate many ideas when dealing with an intangible product. Most of the tourism companies in this study were dependant on, and therefore constrained to, their physical environment upon which their business revolved. Having said this, however, it would not seem difficult to try new things or to add on new extensions to a tourism operation such as longer trips, meals, different equipment, targeted to different markets, or new thrills.

In terms of identifying difference between tourism and manufacturing industries, tourism companies certainly had lower levels of most measures; relatively fewer total activities, less use of activities, significantly less techniques used, less time and staff devoted to Product Development. A general conclusion from this analysis suggests that tourism companies develop their new ventures in quite an informal way, more so than manufacturing companies. However, they still appear to use quite similar activities in the development of their services as in the development of products. Although many activities were infrequently used by many small tourism companies, the fact that all stages were used suggests that they were appropriate in the development of services. Tourism companies, therefore, do use a development process similar to their manufacturing counterparts, however, its usage and benefits are less recognised in this service industry.

The intangibility of tourism products, although more physical than other services such as insurance products and hence less intangible, would naturally result in a less structured development process, more so for the physical activities of the process. Similarly, there is not so much of the simultaneous production and delivery of the service as mentioned by Easingwood (1986). For tourism companies involved in adventure tourism or sightseeing, the majority of their business is concerned with using the physical environment which for the most part is consistent and predictable from day to day. Thus, there is this physical element which is not only tangible but essentially 'produced' before the rest of the service is delivered to the customer.

Tourism operations, although a service, contain a degree of physical, and therefore more tangible, product. The development of a tourism venture can therefore be developed similar to the physical products of manufacturing companies through the use of a systematic development process, although the emphasis on various activities may be different.

Interestingly, many adventure tourism companies have attempted to increase the tangibility of their services by giving the customer T-shirts, certificates, or photographs to take with them. This may also be an efficient and inexpensive form of advertising but it probably gives the customer a physical reminder, or product, of their otherwise intangible experience.

12.0 CONCLUSIONS AND RECOMMENDATIONS

From this study of eighty-four small New Zealand manufacturing companies with less than fifty employees, the following conclusions were made. The companies were in the food, electronics and light engineering industries.

- **The Product Development process as used by New Zealand small manufacturing companies was truncated, missing vital stages, and concentrated on the physical development of the product.**

The typical use of 8 out of 13 stages and the low levels of marketing and financial investigations were conditions predicted based on the results of overseas studies. These small companies did not completely develop their new products before launch in terms of investigating all of the pertinent Product Development issues. Use of a more complete Product Development process would reduce the inherent risks of developing and introducing new products. The use of a more complete Product Development process was correlated with successful products in the marketplace.

Greater awareness and recognition by managers that Product Development is an integrated process that can be applied and controlled throughout the development of new products within their companies would be the first step in improving the use of a structured Product Development process. Greater understanding through training or best practice dissemination may increase the usage of a more complete Product Development process.

- **The techniques used by small companies within the stages of Product Development were simple, easy-to-use and non-complex, and were characterised by informal and reactive approaches.**

In the development of their new products, the small manufacturing companies gathered information about the market, technical aspects, and the developing product itself, by means that provide minimal, simple and superficial information upon which the managers then made Product Development decisions. Company managers and Product Development staff could be made aware of the benefits and use of use of the numerous tools and techniques available to assist in Product Development information collection and decision-making.

The Product Development process and the techniques used within the development stages can be generalised as shown in Exhibit 8.

Exhibit 8 The Development Process Used in New Zealand Small Companies

Idea Generation

The managers perceptions of customers needs and deficiencies of company's products

Idea Screening

A discussion among a group of people without the use of any formal criteria to base their decisions on

Preliminary Market Assessment

Assessment of the market made through direct contact with customers or intuition

Preliminary Technical Assessment

Assessment based on product design and model development

Prototype Development

The prototype constructed with the use of design drawings or specifications

In-House Prototype Testing

Tested using functional or operating tests to ensure it worked correctly

Customer Prototype Testing

Giving the prototype to customers to try

Production Start-Up

Few changes to existing production facilities or equipment

Market Launch

Launching primarily with basic promotion of trade literature and advertising

- **There is a base-level of knowledge internationally for the use of the Product Development process as displayed by a comparison among New Zealand, Canada and Spain practices. New Zealand small company practice more closely followed that of Spanish small companies.**

Although the Product Development processes were similar in the three countries, the New Zealand companies tended to be less extensive practitioners of the Product Development process and used less complex techniques. The New Zealand companies' practice lay between Spanish and the Canadian practice with the Canadian survey showing poorer use of Product Development techniques. Improving New Zealand performance in Product Development in relation to overseas levels will require benchmarking overseas best-practice and disseminating the results. TradeNZ, Chamber of Commerce, and Business Development Boards could play a role in this regard.

- **Management plays a fundamental role in Product Development in small companies. Although they play a key participative role and recognise the necessity for effective Product Development, they are unskilled in how to or are unable to provide the mechanisms to support effective Product Development programmes through lack of resources or time.**

Small company managers need to be trained in how to effectively implement Product Development, firstly by assigning it a key role in the business. Most importantly there is a need for increased financial and staffing resources to be made available to allow a greater level of Product Development to be undertaken.

- **The New Zealand's small manufacturing companies were experiencing only moderate results from their Product Development efforts. Either they were not conducting effective Product Development or they could not capitalise on the efforts due to size-related constraints.**

Although they were producing innovative products, these products were only moderately successful. The company growth rate was slow, and only a few new products were introduced each year. Management must recognise that there exists a direct relationship between Product Development performance and company performance. This attitude may increase the commitment to Product Development and the attention and resources allocated to it.

This exploratory research sets the foundation for further investigations into Product Development in New Zealand companies. Immediate future research should attempt to provide more in-depth analyses of the undertaking of Product Development by the use of case studies and longitudinal studies to provide insight into the nuances of Product Development within the company and how these affect the techniques and undertaking of Product Development, the relationship between the complete Product Development process and product/company success, and how to best attempt to bridge the gap between academic techniques and simple company techniques. Further study should also investigate the nature and variety of products generated from development efforts in New Zealand.

New Zealand has a unique environment in which business is conducted. A greater level of awareness and understanding of Product Development and greater use of Product Development practices combined with greater focus on factors that allow us to compete internationally (such as creativity, improvisation, small company networking, and niche market strategies) could greatly improve our potential competitiveness.

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14.0 APPENDIX

1. QUESTIONNAIRE
2. CORRELATION RESULTS
3. FACTOR ANALYSIS
4. SURVEY DATA SPREADSHEET

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FACULTY OF
TECHNOLOGY

DEPARTMENT OF
CONSUMER
TECHNOLOGY

PRODUCT DEVELOPMENT IN THE SMALL COMPANY SECTOR

Dear Manager

I am writing to you to ask for your assistance in research I am conducting into how small companies develop their new products. This research forms the basis of my thesis and will enable me to complete my Masters degree. This study is therefore private research and has not been initiated by, nor does it involve, Government or any other agency or board.

The area of study of this survey, ie. product development, is one which is not so widely known and one which may not be recognised as such in your company. However, all companies must produce and sell products and services as their source of income and some sort of method is used to develop new ones. I am interested to find out how small companies develop their new products.

To this end, could you please complete the accompanying questionnaire and then return it. It is as concise as possible as I know how busy small business managers can be. The questionnaire has two sections, the first on how you manage the new product development activities, and the second on the actual process and methods used. For most small companies the owner/manager will be responsible for managing the development activities, however, if you have someone else who is responsible for this, could you please complete the management section and then pass it on.

All companies that participate in this study will receive a brief summary and comment on the results. This will provide comparisons with industry norms and suggest practical methods that should help small companies improve their new product efforts.

Could you please try and return the questionnaire by **21 April**. If you do not wish to, or cannot, complete the questionnaire, then could you please write your reasons on the back of the questionnaire and send it back in the envelop provided. This would greatly assist my analysis.

Thankyou for your attention and I hope that you will take the time to complete and return the questionnaire. If you require any further information, do not hesitate to call me. I welcome any information or comment from the business sector.

Yours faithfully

Geoff Kerr
Product Development Masters Student

PRODUCT DEVELOPMENT IN THE SMALL COMPANY SECTOR

Thankyou for agreeing to be involved in this study. Please complete this questionnaire and return it in the enclosed envelope, or fax it to:

Geoff Kerr
Product Development Masters Student
Consumer Technology
Massey University
Private Bag
PALMERSTON NORTH

FAX (06) 350 5657

Product Development is the initiating, developing, testing, and introducing to the market of new or improved products or services.

If you, the manager of the company, is not the person most responsible for new product development, then please complete the first section of the questionnaire, on management, and then pass it on to the other person who has more knowledge of the development activities to complete the last section.

Please feel free to write any additional comments or suggestions. The purpose of this study is to find out how our small companies develop new products, however that may be, and any of your activities or experiences would be most welcomed.

If you have any problems with the questionnaire, need more information about the study, or would like to know more about what we do here at Massey, then please ring me on:

(06) 350-5321

Confidentiality

All information provided by you and your company will be held in the strictest confidence. The questionnaires will be handled by me alone and no identifiable information will be published, unless your permission is given for case study material.

Product Development Management Section

(To be completed by the company manager)

Company name: _____ **Number of Employees:** ___

Managers name: _____ **Age of the company:** ___

Industry Competing In: Main: _____ Sub: _____
(for example: food, electronics, etc)

1. **Who usually carries out new product development activities?** (*Indicate those that apply with the number of employees*)

   Nobody in particular ___
   Production ___
   Technician ___
   Manager ___
   R&D ___
   Marketing ___
   Other _____

2. **How much time, on average, is devoted to new development activities?** (*tick one box*)

   Less than 5 hours a week ___
   About a day a week ___
   Two days per week ___
   Full time ___
   Sporadic (as a project occurs) ___
   Unsure ___

3. **Which of the following best describes the planing conducted in your company.** (*tick the most appropriate box*)

   We don't need to plan ___
   It is pointless trying to plan ___
   We don't have time to plan ___
   We plan for the immediate future (3 months) ___
   We plan for the medium term (1-2 years) ___
   We plan for the long term (3-5 years) ___

4. **Which one of the following best describes the sort of new products or services you typically develop and introduce?**

   We are mainly subcontractors for other companies ___
   Changes in production methods or equipment ___
   Slight changes either in product or service ___
   Moderate changes in product or service ___
   Major extension to an existing line ___
   New product to the company ___
   New product to the local market ___
   New product to the world ___

5. **What is the frequency of new products or services that you introduce to the market per year on average?**

Frequency - _____ new products per year.

6. **Does your company export?** _____ No
_____ Yes - **Where is your main market?** _____

- **What percentage of sales?** _____%

7. **Could you please indicate how much you agree with the following statements** (*Circle the number most appropriate*)

	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
a. Developing new products is crucial to our company's future success.	1	2	3	4	5
b. I actively encourage my employees to be creative and come up with many new ideas.	1	2	3	4	5
c. I am so busy with the daily running of the business I have no time to plan for the future.	1	2	3	4	5
d. Employees are allowed to make many of their own decisions in the development of new products	1	2	3	4	5
e. I make many resources freely available to people working on developing new products.	1	2	3	4	5
f. Employees are rewarded for developing innovative new products.	1	2	3	4	5
g. I actively participate in the new product activities of the company.	1	2	3	4	5
h. In the development of our new products, many rules and procedures are followed.	1	2	3	4	5
i. Communication between me and my employees is excellent in everyday company activities and everyone knows what is going on.	1	2	3	4	5

8. **How successful are the majority of the products that you introduce compared with your pre-introduction expectations and your competitors products? (*circle a number*)**

Most Failed		Mix of fail/success		Highly successful
1	2	3	4	5

9. **How great has your sales growth rate been in the last 3 years?**

Declined/Static	Low	Moderate	High	Very High
1	2	3	4	5

10. **What percentage of your growth rate would you estimate has come from new products you have developed and introduced?**

____ % from new products

11. **Below are some factors that have been identified in past research as effecting the success of new products. Could you please indicate how important you believe they are to small company development efforts.**

		Not Important	Slightly Important	Moderately Important	Very Important	Vitally Important
a.	Product with a relative advantage	1	2	3	4	5
b.	Proficiency of early development activities	1	2	3	4	5
c.	Top management support and commitment	1	2	3	4	5
d.	Product fit with company technology	1	2	3	4	5
e.	Supportive & creative company environment	1	2	3	4	5
f.	Good customer research and marketing	1	2	3	4	5
g.	Systematic, formal development process	1	2	3	4	5

12. **What would you say are the main problems for your company in trying to develop new ventures? (*Please state your main ones*)**

_____

_____

13. **Do you have technically or university qualified employees, ie. with trade certificates, university degrees?**

___ None
___ 1 - 2
___ 3 - 5
___ 6+

14. **What is your personal highest qualification?**

_____

15. **Were you personally in the same line of business or field in your previous occupation?**

___ No
___ Yes

Now, if you are not the main person in your company responsible for managing the new product development activities, please pass the questionnaire on to the person who is so that they can complete the next section.

Product Development Practices Section

(To be completed by person with most responsibility for new developments)

* **Title of person completing this section:** _____

A. Initial Idea

Coming up with or identifying a new idea is the first step in the process of developing a new product and this initial activity is fundamental to how innovative the new product is and how successful the company is.

1. Could you please indicate which of the following have been important sources of new ideas for your company. (*Tick as many as apply*)

Sources Internal to the Manager

- Inventions of the manager ___
- Spontaneous ideas by manager ___
- Managers perceptions of customer problems and needs ___
- Observations of weaknesses in existing company products ___
- Other _____

External Sources

- Imitation of competitors products ___
- Customer (company) suggestions ___
- Customer (consumer) suggestions ___
- Literature ___
- Trade shows ___
- Overseas market ___
- Other _____

Company Sources

- Inventions of employees ___
- Suggestions of employees ___
- Marketing Research ___
- R&D ___
- Sales Rep's Ideas ___
- Informal Discussions ___
- Idea Generation Sessions ___
- Employee responsible for scanning for new product ideas ___
- Other _____

2. How would you best describe your companies approach to generating new ideas? (*indicate where you believe your company lies on the following scale by circling a number*)

Few Ideas/Rely On Competitors				Proactive/Internal Generation of Many Ideas
1	2	3	4	5

B. Product Development Process

B1. **Below is a breakdown of the steps used by a number of companies for the development of new products. Please consider the last product that was introduced to the market by your company and indicate by ticking the box if you used the following stages. Also indicate how relevant you believe the use of the various stages are to small company development efforts on the importance scale next to the box.**

		Use Stage	Not Important	Slightly Important	Moderately Important	Very Important	Vitally Important
a.	**Initial Screening of the idea** *The initial decision where it was first decided to allocate funds to the proposed new product idea*	☐	1	2	3	4	5
b.	**Preliminary market assessment** *An initial market assessment; a first & quick look at the market*	☐	1	2	3	4	5
c.	**Preliminary technical analysis** *An initial, preliminary appraisal of the technical merits of the project*	☐	1	2	3	4	5
d.	**Detailed market research** *Involving a reasonable sample, formal design & collection method*	☐	1	2	3	4	5
e.	**Business/financial analysis** *Leading to a go/no go decision*	☐	1	2	3	4	5
f.	**Prototype design/development** *Design & development leading to the construction of a prototype*	☐	1	2	3	4	5
g.	**In house product testing** *Testing in the lab or under controlled conditions*	☐	1	2	3	4	5
h.	**Customer testing of product** *Customer evaluations of the product*	☐	1	2	3	4	5
i.	**Trial production** *Trial run to test the production facilities & product attributes*	☐	1	2	3	4	5
j.	**Test market/trial sell** *Selling the product to a limited or test set of customers*	☐	1	2	3	4	5
k.	**Pre-launch business analysis** *Prior to full-scale launch*	☐	1	2	3	4	5
l.	**Production start up** *Full-scale commercial production*	☐	1	2	3	4	5
m.	**Market Launch** *Marketing activities specific to this product*	☐	1	2	3	4	5

B2. How successful was this product against your expectations and the competition?

Failed, withdrawn from the market ___
Just surviving ___
Slightly successful ___
Moderately successful ___
Very successful ___
Highly successful/Market Leader ___

B3. How innovative was this product?

Small/incremental change in product ___
Moderate change in product ___
Radical innovation ___

C. Product Development Techniques

C1. Below are a number of techniques that can be used in product development stages. Please tick those which most closely resembles what you do in your development efforts.

a. *Initial Screening of new idea*

1. A group decision, based on an informal discussion - no formal techniques or criteria ___
2. A group decision, based on a formal checklist of criteria ___
3. A single individual made the decision, again on an informal basis (no formal techniques, gut feeling) ___
4. A single individual made the decision, based on formal criteria ___
5. The manager made the decision. ___
6. Stage not done ___

b. *Preliminary Market Assessment*

1. Direct contact with customers ___
2. Knew market already-intuition ___
3. Discussions with the sales force ___
4. Review of competitors products ___
5. Assess secondary/published data ___
6. Casual discussions with retailer/suppliers, etc ___
7. Stage not done ___

c. *Preliminary Technical Assessment*

1. Capability analysis ___
2. Product specifications/recipe ___
3. Product design, model development ___
4. Engineers/designers/scientists assessment ___
5. Literature Investigation ___
6. Stage not done ___

d. *Detailed Market Research*

1. A study of competitive products and prices ___
2. A study of what customers needed or wanted in the new product- to generate product specifications ___
3. A study to determine market size ___
4. Concept testing of idea ___
5. Stage not done ___

e. *Business/Financial Analysis*

1. Costs and sales forecast ___
2. Discounted cash flow analysis ___
3. Return-on-investment analysis ___
4. Payback period &/or break-even analysis ___
5. Superficial analysis: informal, rough guesses & estimates ___
6. Stage not done ___

f. *Prototype Development*

1. Rough 'knock-up' ___
2. Carefully constructed using design drawings/specifications ___
3. Contracted out ___
4. Stage not done ___
5. Other _____

g. *Product Testing - In-House*

1. Prototype testing: to determine if it functioned properly ___
2. Operating tests: checking functioning under real-life working conditions (eg. shelf life, reliability) ___
3. Specifications check: check it met specifications or standards ___
4. Field tests of the product ___
5. Stage not done ___
6. Other _____

h. *Product Testing - Customer*

1. Giving a sample or prototype to some customers to try the product ___
2. Designed customer testing with written testing procedures ___
3. Customers brought to the premises for on-site customer user test ___
4. Reaction at trade shows ___
5. Stage not done ___
6. Other _____

i. *Trial Production*

1. A test of the production system itself (eg. equipment ran smoothly) ___
2. A test of the integrity of the product the production system yielded (eg. to see if specs were met, quality ok) ___
3. Stage not done ___

j. *Test Market/Trial Sell*

1. Selling the product to a sample of selected customers only ___
2. Selling the product in a limited/specific geographic area only ___
3. Selling the product in one or two stores on a trial basis ___
4. Selling the product on a limited basis (very small production) ___
5. Stage not done ___

k. *Pre-introduction business analysis*

1. A detailed financial analysis, involving a return or profitability assessment ___
2. A review of marketing information only: sales forecasts and marketing cost projections ___
3. A cost review: a review of distribution, production and marketing costs ___
4. Stage not done ___
5. Other _____

l. *Production Start-Up*

1. Involved no change to existing production facilities ___
2. Involved few changes to existing production facilities ___
3. Acquisition and commissioning of new equipment or facilities ___
4. Stage not done ___

m. *Market Launch*

1. Prepared trade literature and advertising ___
2. Demonstrated at trade shows ___
3. Customer (public) advertising ___
4. Very limited efforts: virtually nothing special done for launch ___
5. Media Attention ___
6. Other _____

D. Sources of Assistance

Because small businesses often have limited internal resources, they must go outside the company for advice and assistance in their daily business operations and for their new product development endeavours.

D1. Tick the following sources of advice that you regularly use for your business activities and for your new product development activities.

Source of Advice	For Business Advice	For Product Development Advice
Bank Manager	___	___
Accountant	___	___
Lawyer	___	___
Trade Association	___	___
Local Council	___	___
Business Development Boards	___	___
Private Consultants	___	___
Universities	___	___
Local Large Companies	___	___
Local Small Companies	___	___
Outside Individual	___	___
Research Institutes	___	___
Other _____		

D2. Do you feel that your new product development activities and process are adequate?

___Y ___N

D3. Would you welcome more advice and assistance for your new product development efforts if it was readily available at a reasonable rate?

___Y ___N

That completes this questionnaire. Thankyou very much for giving up your time. A sample of 40 companies will be contacted for a brief telephone interview to discuss their development process in more depth. This will also allow you to ask any questions you may have. Tick the following box if you are willing to be involved.

I would be willing to take part in the brief telephone interview ____

Thankyou once again.

Appendix 2 Correlation Results

The correlations below show the relation between the two factors, eg. No verses Total.
* means the relationship is significant at the P <= 0.05 level
** means the relationship is significant at the P <= 0.01 level.

For example, there is a highly significant relationship between the number of employees in the company with the number of people involved in conducting Product Development (and there is a less than 1% chance that this relationship occurred by chance), ie. the more people in the company, the more people they commit to Product Development.

	No	No.	= number of employees in company
Total	.4368**	Total	= number of people involved in PD
	Total	Total	= number of people involved in PD
Total1	.2287*	Total1	= number of development stages
	Future	Future	= new products important to company future
Total1	.2562*	Total1	= number of development stages
	No	No.	= number of employees in company
TimePD	.2313*	TimePD	= time in conducting development
	Total	Total	= number of people involved in PD
Create	.3199*	Create	= manager encourages creativity
	Total	Total	= number of people involved in PD
Envirn	.3185*	Envirn	= a creative environment is important
	Total	Total	= number of people involved in PD
TimePD	.2439*	TimePD	= time in conducting development
	TimePD	TimePD	= time in conducting development
Genideas	.3060**	Genideas	= proactiveness of idea generation
	Type	Type	= innovation type of products
TimePD	.3078**	TimePD	= time in conducting development
	Type	Type	= innovation type of products
Genideas	.3633**	Genideas	= proactiveness of idea generation
	Type	Type	= innovation type of products
Ratenp	.3681**	Ratenp	= contribution of products to growth
	Success	Success	= success of majority of products
Success1	.3958**	Success1	= success of last product introduced
	Success	Success	= success of majority of products
Type	.2369*	Type	= innovation type of products

	Success	Success	= success of majority of products
Rules	.3082**	Rules	= having procedures for PD
	Success1	Success1	= success of last product introduced
Type	.2382*	Type	= innovation type of products
	Planning	Planning	= the extent to which companies plan
Type	.2465*	Type	= innovation type of products
	Marketing	Marketing	= marketing person involved in PD
Type	-.5041*	Type	= innovation type of products
	Rules	Rules =	having procedures for PD
Process	.4873**	Process	= having a recognised PD process
	Total1	Total1	= number of development stages
Innosuc	.2353*	Innosuc	= innovation/success measure
	No	No.	= number of employees in company
Innov	-.3735**	Innov	= innovativess of last product
	Type	Type	= innovation type of products
B	.3633**	B	= preliminary market assessment
	Type	Type	= innovation type of products
I	.3510*	I	= conducting a trial production
	B	B	= preliminary market assessment
C	.6977**	C	= preliminary technical assess.
	Total	Total	= number of people involved in PD
Freqnp	.3895**	Freqnp	= number of new products introduced
	Marketing	Marketing	= marketing person involved in PD
Freqnp	.6619**	Freqnp	= number of new products introduced
	Resources	Resources	= manager provides resources for PD
Freqnp	.2944*	Freqnp	= number of new products introduced
	Ratenp	Ratenp	= contribution of products to growth
Techstaff	.2704*	Techstaff	= technically qualified staff
	Partic	Partic	= manager participate in PD
Qual	.2678*	Qual	= Qualifications of management

Appendix 3 Factor Analysis

INITIAL STATISTICS:

VARIABLE	COMMUNALITY	*	FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
		*				
RELADV	1.00000	*	1	3.59846	22.5	22.5
EARLY	1.00000	*	2	1.95274	12.2	34.7
TOPMANG	1.00000	*	3	1.57971	9.9	44.6
TECHFIT	1.00000	*	4	1.25632	7.9	52.4
ENVIR	1.00000	*	5	1.15057	7.2	59.6
CUSTRES	1.00000	*	6	.97682	6.1	65.7
PROCESS	1.00000	*	7	.92482	5.8	71.5
FUTURE	1.00000	*	8	.80502	5.0	76.5
CREATE	1.00000	*	9	.74922	4.7	81.2
BUSY	1.00000	*	10	.67334	4.2	85.4
OWNDEC	1.00000	*	11	.58181	3.6	89.1
RESOURCE	1.00000	*	12	.48025	3.0	92.1
REWARD	1.00000	*	13	.43437	2.7	94.8
PARTIC	1.00000	*	14	.33763	2.1	96.9
RULES	1.00000	*	15	.26656	1.7	98.5
COMMUN	1.00000	*	16	.23236	1.5	100.0

PC EXTRACTED 5 FACTORS.

FACTOR MATRIX:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
ENVIR	.73524				
RESOURCE	.69864				
CREATE	.64738				
REWARD	.53212				
TOPMANG	.52128				
FUTURE					
RULES		.81471			
OWNDEC		-.58876			
PROCESS					

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
COMMUN			-.60149		
PARTIC	.50320		-.57976		
EARLY					
RELADV					
BUSY	-.60180			.61286	
[illegible]					.58858

FINAL STATISTICS:

VARIABLE	COMMUNALITY	*	FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
		*				
RELADV	.34992	*	1	3.59846	22.5	22.5
EARLY	.50766	*	2	1.95274	12.2	34.7
TOPMANG	.53311	*	3	1.57971	9.9	44.6
TECHFIT	.69269	*	4	1.25632	7.9	52.4
ENVIR	.68097	*	5	1.15057	7.2	59.6
CUSTRES	.59289	*				
PROCESS	.71613	*				
FUTURE	.40083	*				
CREATE	.52264	*				
BUSY	.76127	*				
OWNDEC	.76708	*				
RESOURCE	.65318	*				
REWARD	.32259	*				
PARTIC	.75332	*				
RULES	.70238	*				
COMMUN	.58116	*				

VARIMAX ROTATION 1 FOR EXTRACTION 1 IN ANALYSIS 1 - KAISER NORMALIZATION.

VARIMAX CONVERGED IN 9 ITERATIONS.

- - - - - - - - - - - F A C T O R A N A L Y S I S - - - - - - - - - - -

ROTATED FACTOR MATRIX:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
BUSY	-.86437				
FUTURE	.57896				
RELADV					
REWARD					
CREATE					
OWNDEC		.83525			
RESOURCE		.65837			
ENVIR		.61681			
PARTIC			.83757		
COMMUN			.71987		
TOPMANG			.50002		
PROCESS				.82369	
RULES				.62608	
CUSTRES				.57429	
TECHFIT					.80615
EARLY					.55411

FACTOR TRANSFORMATION MATRIX:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
FACTOR 1	.66494	.52135	.45933	.25920	.08875
FACTOR 2	-.06773	-.60499	.37272	.61613	.33297
FACTOR 3	.21780	.13278	-.75556	.34319	.49628
FACTOR 4	-.70400	.57427	.19358	.20151	.31068
FACTOR 5	.10107	-.12147	.20436	-.62834	.73379

Appendix 4 Survey Data Spreadsheet

name	industry	no.	age	nobody	prodn	tech	mang	R&D	marktg	other	TOTAL	timepd	planning	type	freqnp	export	where	sales%
1	1	38	9		1		1	3			5	6	5	5	30	1	3	3
2	1	14	8				1				1	3	4	4	1	1	1	1
3	1	8	10				1				1	3	5	6	1			
4	1	45	15		1		1	1			3	2	4	3	6			
5	1	14	30		1		1				2	2	5	3	1.5	1	4	3.5
6	1	10	23				1				1	2	5	4	1			
7	1						1		1		2	4	5	7	5			
8	1	24	13		1		1		1		3	2	5	4		1	1	20
9	1	8	11				1				1	3	6	6	6			
10	1	4	41								0							
11	1	5	5				1				1	3	5	6	3	1	1	5
12	1	20	1						2		2	3	6	6	10			
13	1	20	10				2		1		3	6	5	6	10	1	1	2
14	1		35		1	1			2		4	3	4	6	5			
15	1	12	29				1				1	2	5	3	0.5			
16	1	9	24		1		1				2	1	5	4	2	1	6	50
17	1	38	11				1				1	2	5	6	2	1	1	10
18	1	38	11		1		1		1		3	4	6	5	6	1	1	25
19	1	40	10				2				2	2	6	7	2	1	3	80
20	1		14					1			1	6	5	6	6			
21	1	23	30				1		1		2	2	5	6	2	1	1	0.5
22	1	22	12				2				2	3	5	5	3			
23	1	28	21		1		1		1	1	4	2	6	6	8			
24	1	15	15		1		1				2	3	4	3	2			
25	1	6	6				2				2	2	5	6	1	1	6	12.5
26	1	25	4		1		1				2	2	5	3	2			
27	1	6	15				1				1	2	5	4	3	1	1	8
28	1	10	47				1				1	5	6	6	1.5	1	6	40
29	1	10	10				1				1	3	6	6	1			
30	1	24	10				1				1	3	5	2	1.5	1	3	20
31	1	2	6				1				1	3	1	3	1			
32	1	55	8		2	2	1		1		6	2	6	5	3	1	1	15
33	3	12	10		1			1			2	4	6	6	1	1	1	6
34	3	9	20				1				1	2	3	7	2			
35	3	20	10					1			1	6	5	6	6	1	3	5
36	3	40	25					1			1	5	5	4	4	1	4	5
37	3	43	10		1	1	1		1		4	3	5	7	3			
38	3	6					1			1	2	1	4	1				
39	3	8	16				1				1	2	5	5	3			
40	3	12	4			1	1				2	4	5	5	2	1	1	2
41	3	60	22				1				1	4	5	5	3	1	1	20
42	3	11	50				1				1	2	5	7	0.5	1	1	25
43	3	2	30		1		1				2	3	5	4	0.75			
44	3	6								1	1	6	6	7	2			
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53	3	13	6				1				1	2	5	7	4.5	1	1	15
54	3	70	118								0	4	5	5	3			
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58	3	14	17				1				1	2	5	5	1			
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75	2	150	30					1			1	6	6	8		1	6	60
76	2	22	40				1				1	3	5	3	1			
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111	2	3	7				1				1	2	5	5	2	1	4	2
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name	future	create	busy	owndec	resource	reward	partic	rules	commun	success	sales d	rate%np	reladv	early	topmang	techfit	envir	custres	process	probs1
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