Evaluating New Product Development Performance in Small to Medium Sized Manufacturing Firms

by

Charles Edward O'Mara

A thesis presented to the University of Western Sydney in partial fulfilment of the requirements for the degree of Doctor of Philosophy

March 2009

© Charles E O'Mara

Dedication

I dedicate this thesis to my family for their unwavering support and encouragement.

Acknowledgement

I would like to thank my supervisors for accompanying me along this journey. My principal supervisor, Professor Ross Chapman was with me from the beginning. His knowledge of the discipline and insightful analysis and feedback of my work provided continual encouragement.

My co-supervisor, Associate Professor Terry Sloan came on board for the latter half of this project and his energy provided the impetus to press on to completion. Prompt feedback and friendly enquiries as to progress was a feature of our working relationship.

Special thanks go to Professor Harry Boer at the Centre for Industrial Production at Aalborg University, firstly for inviting me to include my NPD research in his benchmarking survey, and later for exchanging ideas on performance improvement in SMEs. I would also like to acknowledge the early contributions of Professor Paul Hyland, a colleague at UWS who has since moved on to the University of Queensland.

To my work colleagues who have offered encouragement along the way, I would like to give a special mention to Anneke Fitzgerald and Stephen Waters.

Thanks also go to Mrs Marian Paap for formatting of final version of this document. The transcripts of interviews were most capably done by Mrs Stephanie Miller. Both of you made the task of completing this thesis so much easier.

Finally, special thanks are due to my family for the inspiration they provided. To my children Kathryn, Alison and Colin, and especially to my wife Jean, words cannot express the depth of appreciation and love I feel for the encouragement you offered along the way.

Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in part or in full, for a degree at this or any other institution.

_____

Charles Edward O'Mara

October 2008

Table of Content

Dedication ii
Acknowledgement iii
Statement of Authentication iv
Table of Content v
List of Tables ix
List of Figures xi
Appendices xii
Abstract xiii

Chapter 1

1.1 Introduction 1
1.2 Background to the Research 2
1.3 Research Problem and Research Questions 3
1.4 Justification for the Research 7
1.5 Methodology 9
1.6 Definitions 10
1.6.1 Innovation and New Product Development Definitions 10
1.6.2 Performance Measurement Definitions 12
1.6.3 Definitions of Survey Instrument Terms 13
1.7 Delimitations and Scope 14
1.8 Key Assumptions 15
1.9 Outline of the Thesis 16
1.10 Conclusion 17

Chapter 2

NEW PRODUCT DEVELOPMENT 18
2.1 Introduction 18
2.2 Terminology 18
2.3 New Product Development Process 23
2.4 Critical Success Factors in New Product Development 26

2.5 Strategic Alignment of New Product Development Activities.....26
2.6 Formal New Product Development Processes.....28
2.7 Managing and Improving the New Product Development Process.....29
2.8 Small and Medium-sized Businesses and New Product Development 37
2.9 Summary.....40

Chapter 3

PERFORMANCE MEASUREMENT 42
3.1 Introduction.....42
3.2 Performance Measurement Defined 43
3.3 Why Measure Performance.....46
3.4 Design of Performance Measurement Systems 50
3.5 Performance Measurement for Product Innovation.....54
3.6 Conclusion 68

Chapter 4

METHODOLOGY 70
4.1 Introduction.....70
4.2 Development of a Theoretical Framework 72
4.3 Development of the Data Collection Instruments.....75
4.4 Data Collection 80
4.5 Data Analysis.....83
4.6 Conclusion 88

Chapter 5

QUANTITATIVE DATA ANALYSIS 89
5.1 Introduction.....89
5.2 Research Question One – Strategic Alignment 89
5.2.1 The Business Unit's Competitive Strategy 91
5.2.2 New Product Development Competitive Priorities.....93
5.2.3 Performance Evaluation.....96
5.2.4 Summary of Analyses Regarding Research Question 1 99

5.3 Research Question 2 – Management Action Programs 100
5.3.1 New Product Development Action Programs.....101
5.3.2 Effectiveness of New Product Development Action Programs.....103
5.3.3 Future Action Programs.....105
5.3.4 Summary of Analyses Regarding Research Question 2 107
5.4 Research Question Three - Management of NPD Projects.....108
5.4.1 New Product Process Management and Innovativeness.....108
5.4.2 New Product Process Management and Performance 111
5.4.3 Reputation for New Product Development.....111
5.4.4 Time-to-Market Performance 112
5.4.5 Summary of Analyses Regarding Research Question 3 113
5.5 Research Question Four – Measuring NPD Performance 113
5.5.1 Does Performance Measurement Inform Strategy in SMEs?.....114
5.5.1.1 Time-to-Market Performance Dimension.....115
5.5.1.2 Quality Performance Dimension.....118
5.5.2 Summary of Analyses Regarding Research Question 4 120
5.6 Summary and Key Findings.....121

Chapter 6

QUALITATIVE DATA ANALYSIS 123
6.1 Introduction.....123
6.2 Participating Organisations.....123
6.3 Qualitative Interview Proforma 124
6.4 Research Question One – Strategic Alignment 126
6.4.1 Analysis of Company A Responses.....127
6.4.2 Analysis of Company B Responses 129
6.4.3 Analysis of Company C Responses 132
6.4.4 Interview Observations: Research Question One – Strategic Alignment 134
6.5 Research Question 2 – Management Action Programs 135
6.5.1 Analysis of Company A Responses.....136
6.5.2 Analysis of Company B Responses 139
6.5.3 Analysis of Company C Responses 143

6.5.4 Interview Observations: Research Question Two – Management Action Programs 146
6.6 Research Question Three - Management of NPD Projects.....148
6.6.1 Analysis of Company A Responses.....149
6.6.2 Analysis of Company B Responses.....151
6.6.3 Analysis of Company C Responses.....154
6.6.4 Interview Observations: Research Question Three – Management NPD Projects.....156
6.7 Research Question Four – Measuring NPD Performance 157
6.7.1 Analysis of Company A Responses.....158
6.7.2 Analysis of Company B Responses.....161
6.7.3 Analysis of Company C Responses.....165
6.7.4 Interview Observations: Research Question Four – Measuring NPD Performance.....167
6.8 Summary and Key Findings.....169

Chapter 7

DISCUSSION AND CONCLUSIONS 171
7.1 Introduction.....171
7.2 Conclusions about the Research Questions 173
7.2.1 Research Question One – Strategic Alignment 173
7.2.2 Research Question Two – Management Action Programs.....175
7.2.3 Research Question Three – Management of NPD Projects.....178
7.2.4 Research Question Four – Measuring NPD Performance 180
7.3 Implications for Theory 182
7.4 Implications for Policy and Practice.....183
7.5 Limitations.....187
7.6 Implications for Further Research 188
7.7 Contributions of the Research.....189

List of References.....191

Appendices.....201

List of Tables

Table 1.1: Research Problem and Issues Under Investigation 6
Table 2.1: New Product Categories, based on Crawford & di Benedetto (2003, p.12) 19
Table 2.2: Categories of Research and Development, Based on Roussel et al., (1991) 22
Table 2.3: Models of the New Product Development Process, Based on Saren (1984) 24
Table 3.1: Criteria Used to Measure New Product Performance 58
Table 3.2: Summary of Cycle Time Measurement Variables 60
Table 3.3: Performance Measures for Innovation Considered in the Survey 67
Table 4.1: Data Analysis Matrix 87
Table 5.1: Market Share of New Products 91
Table 5.2: Business Unit Competitive Strategies 92
Table 5.3: New Product Development Competitive Strategies 93
Table 5.4: NPD Strategies that Support Business Unit Strategies 96
Table 5.5: Performance Assessment 97
Table 5.6: Degree of Effort during the Last Three Years 101
Table 5.7: Benefits Derived from New Product Development Action Programs 104
Table 5.8 Expected Emphasis in the Next Three Years 106
Table 5.9: Innovativeness and NPD Management 110
Table 5.10: Chi-squared Analysis of Innovativeness and NPD Management ... 110
Table 5.11: Time-to-Market: Past Performance and Future Action 115
Table 5.12: Time-to-Market: Past Performance and Future Action – Averaged Responses 116
Table 5.13: Time-to-Market Performance 117
Table 5.14: Chi-square Analysis of Time-to-Market Performance 117
Table 5.15: Conformance Quality: Past Performance and Future Action 118
Table 5.16: Conformance Quality: Past Performance and Future Action – Averaged Responses 119

Table 5.17: Chi-square Analysis of Conformance Quality Performance 120
Table 5.18: Results of Chi-square Analysis 120
Table 6.1: Qualitative Interview Participating Business Units 123
Table 6.2: Qualitative Interview Participants' Titles 124
Table 6.3: Research Questions and the Qualitative Interview Questions 125
Table 6.4: Research Question One Comparison Summary of Interview Findings 135
Table 6.5: Research Question Two Comparison Summary of Interview Findings 147
Table 6.6: Research Question Three Comparison Summary of Interview Findings 157
Table 6.7: Research Question Four Comparison Summary of Interview Findings 168

List of Figures

Figure 2.1: Opportunities for Knowledge Transfer within and Between Projects 35

Figure 2.2: Elements in the CIMA Explanatory Model for Learning in Continuous Product Innovation 36

Figure 2.3: Conceptual Model of the Drivers of High Growth. (O'Regan et al., 2006) 39

Figure 3.1: The Innovation Process (Chiesa et al., 1996, p.107) 63

Figure 4.1: Drivers of New Product Development Performance 73

Figure 4.2: Theoretical Framework 74

Figure 4.3: Development of the Data Collection Tools 78

Figure 4.4: Evolution of the Survey Instrument and Interview Pro-forma 79

Figure 5.1: Linking Outcomes to Strategy 90

Figure 5.2: NPD Process Management 109

Figure 5.3: NPD Reputation 112

Figure 5.4: Time-to-Market Comparison 112

Figure 7.1: Theoretical Framework Incorporating the Research Questions..... 172

Figure 7.2: A process for Integrating Strategy, Actions and Performance Measurement to Improve NPD Performance in SMEs..... 186

Appendices

Appendix 1: Business Unit Quantitative Survey 201
Appendix 2: New Product Development Unit Quantitative Survey 212
Appendix 3: Qualitative Survey Pro-forma 226
Appendix 4: CIMA Model Behaviours and Examples of Leavers 227
Appendix 5: Sample Transcript Interview 229
Appendix 6: New Product Development Performance Dimensions 237
Appendix 7: New Product Development Action Programs 238

Abstract

The purpose of the research undertaken for this thesis was to examine management practices relating to new product development processes in small to medium-sized manufacturing firms (SMEs). The thesis topic has its origins in a European Community funded research project carried out during 1997-9 and designated CIMA (Continuous Improvement in Global Innovation Management) ESPRIT project 26056. The CIMA project had as its objective the development, testing and dissemination of a methodology to support knowledge transfer in the product innovation process. The CIMA model suggested a relationship between management behaviours and performance outcomes that used literature from a variety of research areas including continuous improvement, product innovation, performance measurement, and inter-project learning. This literature was centred largely on research undertaken in large organisations, with little information available on the new product development (NPD) practices in SMEs.

This thesis sought to examine the management of NPD activities in SMEs across a range of important variables as identified in larger organisations in an effort to evaluate whether they were as relevant in smaller organisations. The literature review reduced the research to four broad questions:

1. what is the relationship between a business unit's competitive strategy and its new product development strategy,
2. how management involvement in improving NPD performance,
3. does a more systematic approach to management of NPD projects would lead to better outcomes, and finally
4. how new product development performance is measured in SMEs.

A two-stage, field based research methodology was used to gather data for this thesis. Firstly, a quantitative survey instrument was used to collect data across a broad range of variables. The data thus gathered were supported by a subsequent set of interviews in three SMEs that. In each of these firms, employees from the broad

functional areas of sales, operations, and design, were interviewed to gain a greater understanding of the issues that might emerge in the quantitative survey. Thematic analysis was used to examine the qualitative data. Descriptive statistics, in the main were used to evaluate the quantitative data.

Findings relevant to each of the research questions provide valuable insights into NPD practices in SMEs. For instance, strategies tend to be hazy, and have a short term emphasis. The qualitative interviews in particular showed a lack of certainty and direction when it came to strategy. With regard to management involvement, there was more emphasis on individual effort rather than team-based activities. Managers tended not to look for external sources to improve their NPD performance. The approach taken in managing NPD activities, whether it was systematic or informal, did not appear to affect innovativeness, though it did appear to impact other variables such as time-to-market. Finally, performance measurement in SMEs tended to emphasise cost outcomes as opposed to variables critical to customers such as conformance quality or time-to-market. Further, outcomes in those performance dimensions did not appear to influence future strategy or actions within the organisations. A detailed review of the data is provided in chapters five, six and seven.

Chapter 1

1.1 Introduction

Product innovation has become an increasingly important competitive factor for both large and small companies. The complexity of the innovation process, in terms of both the technologies, and the range of people and companies involved, has also increased considerably. Despite its complexity, organisational renewal demands that the dynamics of innovation and organisational change be mastered (Tushman and O'Reilly, 1997).

Different conceptual models have been proposed identifying general principles and criteria to understand and manage product innovation as a knowledge creating process. Most contributions, however, are still aimed at proposing generic models that do not take into account firms' specific characteristics and are therefore limited in their ability to provide relevant solutions to company-specific problems in improving product innovation processes. Within the broader innovation process, significant emphasis is falling on new product development (NPD) practices. In many industries new product development is a key determinant of success or failure (Schilling and Hill, 1998). Recent studies have shifted the research focus from management of new product development projects, seen as isolated efforts, to the overall process of Continuous Product Innovation (Sanderson and Uzumeri, 1995, Bartezzaghi et al., 1997, Corso and Pavesi, 2000).

Measurements of the effectiveness of new product development typically concentrated on meeting development budgets (cost) and satisfying design criteria (performance) (Kessler and Chakrabati, 1999). During the last decade, time spent in the product development cycle has come under scrutiny (Allocca and Kessler, 2006, Cooper, 1994, Griffin, 1993). Increasingly, efforts to understand and improve new product development processes, have involved the development of a broader range of performance metrics, devoted not just to the outputs of the process but also to those behaviours that underlie new product development practices.

This thesis will investigate new product practices and performance in small to medium sized manufacturing firms. It will look at how these business units manage and measure their NPD processes.

1.2 Background to the Research

Growing awareness of the need to manage innovation for competitive advantage has resulted in growing interest and research in innovation processes, and in particular the processes through which new products emerge. Organisations increasingly look to develop new products both as a wellspring of renewal and a source of high profits. For organisations to survive in the long run, they must not only be efficient, they must also be innovative (Serwer, 1994). There has been a shift in perspective that saw innovation activity as discrete and confined to a narrow section of the organisation (Roussel et al., 1991). It is now seen as a process that impacts on the organisation as a whole, "where successful product development is the result of careful planning and … the execution of that plan by a competent and well-coordinated cross-functional team" (Brown and Eisenhardt, 1995, p.348).

Becoming better at introducing new products requires a clear understanding of the process that leads to their development. Improving the process requires that its effectiveness, and the impact any changes might have on it, can be measured. The development of performance metrics for new product development has evolved slowly. In one of the earliest studies of new product development practices, Richardson and Gordon (1980) found that the performance measures in use actually inhibited the firms' innovation process. In 1992, Mahajan and Wind surveyed the tools, methods and 'models' used for measuring new product development, in order to evaluate the role of these models in supporting and improving the new product development process. Griffin (1994) emphasises the importance of measuring product development cycle times, and discussed a range of metrics for evaluating it.

More recent contributions to evaluating new product development performance have focused on a variety of issues. Caffyn (1998) developed a scale for measuring behaviours that support continuous improvement in the new product development process. Kerssens-van Drongelen (1999) published a thesis outlining the systematic

design of R&D performance measurement systems. Gieskes (2001) published a thesis that examined an extensive research program into learning and knowledge management in the new product development process, known as the CIMA (Continuous Improvement in the Management of Innovation) project (Boer et al., 2001, Chapman et al., 2001). The CIMA project examined three aspects of new product performance, namely, project performance, improvement performance, and people performance. The results obtained on performance measurement of new product development were inconclusive, and showed a wide variation in responses from the organisations that were surveyed. Why this should be the case is uncertain, but it may be connected with the specific strategies that the organisations were pursuing. The importance of linking performance metrics to strategy has been well documented (Kaplan and Norton, 1993, Neely et al., 1997, O'Mara, 1996).

In the context of new product development, the organisation's strategic focus should inform its new product development strategy. The success, or otherwise of the new product development strategy should in turn be monitored by performance metrics that provide feedback for future decisions and actions. As well, differences between organisations such as of size, structure and culture, and market complexity could also explain different outcomes. Specifically, important differences have been found to exist between large organisations, and small-to-medium sized organisations with regard to their new product development practices (O'Shea and McBain, 1999, Chapman et al., 2001, O Shea and McBain, 1999, Woodcock et al., 2000). It was from these differences that the current research problem emerged.

Examining the link between strategy, action programs, measurement and outcomes in new product development practices forms the basis of this thesis. The research questions emerging from this study are detailed in the following section.

1.3 Research Problem and Research Questions

The previous sections highlighted the importance of new product development processes and the significant role of performance measurement in process improvement. Additionally, the strategic context within which new products are developed has been identified as an important ingredient in their success (Hart,

1993, Tidd et al., 1997). Most studies concentrate on large organisations with clearly defined new product development processes and functional areas devoted to new product development. Smaller organisations (those with less than 200 employees) have exhibited substantial performance differences with regard to their new product development practice and performance (Chapman and O'Mara, 2001). Innovation processes tend to be less formalised and less well understood by small business managers. Nevertheless, a large number of small firms display strong innovative capabilities, and produce a range of new products.

The research problem at the core of this study was whether SMEs follow best practice as reported in large organisations. This research was undertaken in order to identify and assess new product development practices and performance in small to medium-sized manufacturing firms. These would be compared to best practice performance in large organisations as identified in the literature. Four research questions emerged from the literature review and these are presented below.

The first research question involved the relationship between the organisation's competitive strategy, and its new product development strategy, and whether linkages here impact positively on new product development performance, as subjectively evaluated by survey respondents. Extant literature supports the position that organisations should align their new product development strategy with their overall business strategy (Cooper and Kleinschmidt, 1996a, Christensen, 1999, Trott, 2005).

The second research question examined the relationship between management of the new product development process and NPD performance. According to the literature, organisations can improve their NPD performance by building relevant capabilities (Prahalad and Hamel, 1990). Building capabilities is accomplished through management intervention in the form of action programs (Bartezzaghi et al., 1997, Boer et al., 2001, Chapman and O'Mara, 2001). In the context of this study, management involvement in new product development would be evaluated by identifying action programs that are initiated in order to improve the NPD process. Under investigation would be the extent to which managers in SMEs actively

manage their NPD processes through action programs and whether performance improves as a result.

The literature review presented in Chapter 2 provided solid support for the position that structured approaches to innovation management in large organisations led to better outcomes (Booz et al., 1982, Cooper, 1994, Griffin, 1997, Leseure, 2000). In the previous section, reference was made to the possible negative effect of performance measurement on innovation (Richardson and Gordon, 1980). The suggestion was that tight controls inhibit innovativeness. The concept of control was further explored by Butler et al., (1998), but in a structural context. The two types of structures they describe are crisp and fuzzy, an organisational analysis originally described in Lerner and Wanat (1983), and later developed by Butler (1991).

In a structural context, small businesses exhibit predominantly fuzzy structures. This is likely to encourage creativity, but possibly at the expense of performance. Whilst there are many constraints in developing new products in small firms, not least of which is finance, structure is not likely to be one of them, but given the financial constraint, tighter control of innovation processes should be a high priority for such firms. The third research question investigated in this study was whether a systematic approach to NPD would lead to better outcomes.

One would expect strategic direction to influence the choice of action programs and appropriate performance measures to monitor progress (Dixon et al., 1990). Performance, properly measured, should also inform strategy and action (Kaplan and Norton, 1996a). In other words, the outcomes of a process should feed back into subsequent strategic plans and action programs. The fourth and final research question investigates whether SMEs measure NPD performance, and whether performance outcomes impact on business-level and new product development strategy.

The research problem and related research questions are summarised in Table 1.1.

Table 1.1: Research Problem and Issues Under Investigation

Research Problem	The extent to which SMEs follow best-practice in New Product Development as identified in academic literature
Research Question 1	Is the business unit's competitive strategy supported by its NPD strategy?
Research Question 2	What is the level of management involvement in improving new product development processes and performance?
Research Question 3	How should SMEs manage their new product development projects?
Research Question 4	Do SMEs measure NPD performance, and does such measurement influence strategy?

In order to investigate these research questions, three survey instruments were developed (Appendices 1, 2, and 3). Appendix 3 is the qualitative interview pro-forma. Appendix 1 was developed to gather demographic data on the participating organisations. Appendix 2 gathered quantitative data on NPD practices and performance in small-to-medium sized firms across a range of dimensions including:

a) competitive priorities for NPD strategy
b) drivers of NPD strategy
c) Measurement of NPD performance dimensions
d) reasons for wanting to improve production performance
e) NPD project management
f) Organisational structure for product development
g) Communication processes within the firm
h) Teamwork
i) Training and skill levels
j) Innovativeness of the organisation

Development of the survey instruments is more fully discussed in the methodology Chapter 4.

1.4 Justification for the Research

During the literature review that was conducted as background to this research it became clear that innovation is essential for the long-term survival of organisations (Bowen et al., 1994, Cooper and Kleinschmidt, 1996a, Tushman and O'Reilly, 1997). The complexities associated with innovation have seen various aspects of the process broken down for intensive analysis. Areas to receive particular attention are the sources of innovation (von Hippel, 1986), research and development (Francis, 1992, Kerssens-van Drongelen, 1999, Lander et al., 1995), and new product development (Boer et al., 2001, Cooper and Kleinschmidt, 1986, Crawford and Di Benedetto, 2003, Griffin and Page, 1993). The sources of innovation literature deals with idea generation, knowledge creation and its application, and selection of projects for further research. Research and development involves the necessary research as a precursor to possible commercialisation of this new knowledge, and the development of designs for prototype testing prior to production. New product development activities place emphasis on speedy development of new products and the production processes that will lead to commercial production and product launch. Needless to say there is considerable overlap between these areas, and recent studies show that having cross-functional teams was an important ingredient in better performing innovative firms (Di Benedetto, 1999, Lynn and Reilly, 2000).

The importance of innovation for the long-term prospects of organisations provided the early rationale for research, and narrowing the focus of the research for this thesis came about through a detailed examination of the literature.

New product development activities have received by far the greatest attention in innovation literature, even though NPD is only one part of the innovation process. The emphasis on new product development is justifiable from several perspectives. Firstly, when it comes to innovation, the costs associated with new product development are generally the highest (Trott, 2005). The further along the innovation process an organisation progresses, the greater the cumulative costs. Thomke and Fujimoto (2000, p.129) noted that solving problems becomes "increasingly expensive and time consuming as projects progress and financial

commitments are made". This should place heavy managerial emphasis on product development activities. Secondly, the development lead-time for new products is critical, both in terms of their life cycle, and their chances of success (Cooper and Kleinschmidt, 1994, Wheelwright and Clark, 1992b). New product development performance is especially important in industries with short product life cycles (Loch et al., 1996). Getting products to market ahead of the competition also makes fast development an important component of new product development success (Cooper and Kleinschmidt, 1987, Di Benedetto, 1999). Finally, each new product development project provides opportunities for learning that should feed back into the innovation cycle and product development cycle in order to generate process improvement (Bartezzaghi et al., 1997, Boer et al., 2001, Caffyn, 1998, Gieskes, 2001).

Having decided that new product development is a worthwhile topic for further research, the next step was to determine the scope of the research in this extensive and complex area. Early research into new product development activities tended to be broad-based, looking for factors that contributed to the success or failure of product development projects (Booz et al., 1968, Booz et al., 1982). Similar broad-based surveys were conducted by the Product Development and Management Association (PDMA) in 1990 and 1995 (Griffin, 1997, Page, 1993). Along with such studies, more targeted research into new product development has been conducted. Significant contributions include the research of Lynn and other into the role of teams and teamwork in new product development success (Lynn, 1998, Lynn et al., 1998, Lynn and Reilly, 2000, Lynn et al., 1999); the work of Caffyn (1998) and Bartezzaghi and other (1997) into continuous improvement in product innovation; and the work of a large group of people into the role of learning and knowledge management in the new product development project, known as the CIMA project (Boer et al., 2001).

The CIMA project, which is reported on in greater detail in chapter two, identified several areas if interest. Two are of principal concern in this research. First, was the poor use of performance metrics to improve innovation, and in particular, new product development processes (Chapman et al., 2001). Second was the significant difference between large and small organisations with regard to learning and

knowledge management in the new product development process (Chapman and O'Mara, 2001). It became apparent from a review of the CIMA research data that different NPD processes were necessary in larger organisations than small organisations, for instance, cross-functional teams and better, more formalised knowledge management and diffusion processes (Chapman et al., 2001).

Past research into new product development predominantly focused on large corporations with clearly defined processes. The picture is not so clear, nor is it well researched amongst smaller firms, even though they far outnumber large corporations. This research will contribute to a growing number of studies that address NPD practices in SMEs.

1.5 Methodology

In the discussion on the research problem it was stated that the research was undertaken in order to identify and assess new product development practices and performance in small to medium-sized manufacturing firms. As such the research involved both theory development and analysis. The theory development component firstly required a literature review to establish the current position with respect to models that purported to describe and measure new product development performance. The literature review led to the development of the model presented as Figure 4.2 in the Methodology chapter. It is not a model of the NPD process, which receives considerable attention in Chapter two. Rather, it is a theoretical model of important drivers of NPD performance, as identified in the literature. These drivers of NPD performance are embodied in the research questions and are examined in this study. Survey instruments were developed to collect data relevant to the four research questions. Analysis of this data would shed light on the research questions, and in particular on whether practices that supported NPD in large organisations did the same in SMEs.

The literature review was carried out in the broad areas of innovation and performance measurement, with particular emphasis on new product development processes, and the use and impact of performance measurement on those processes. Having identified a research problem, survey questionnaires were developed to

gather data on company demographics and new product performance and practice. Appropriate research methodologies in the area of organisational behaviour are discussed in chapter four, as are the practical considerations that impacted upon the design of the survey instruments and interview pro-forma. The data collection was carried out using in a two-stage study. Firstly, a broad-based quantitative survey gathered data from 56 SMEs in order to investigate their practices in the area of new product development. This was followed by in-depth interviews in three small to medium sized manufacturing firms.

1.6 Definitions

This research focuses on new product development (NPD) practices and performance. New products emerge in innovative firms through their innovation process. The innovation process itself consists of a range of activities that ultimately results in the creation of marketable of goods and services with varying degrees of originality. In this section, the important words and phrases used throughout the thesis are defined. These definitions cover:

- innovation and new product development concepts (Chapter 2),
- performance measurement concepts (Chapter 3), and
- specific concepts used in the quantitative survey instrument (Chapter 5).

1.6.1 Innovation and New Product Development Definitions

The innovation process, as described in 'Innovation – your move'(Voss et al., 1994) covers four broad activities – product innovation, product development, process innovation, and technology acquisition. Of principal concern in this thesis is product development. New product development is concerned with "taking the new product concept or product enhancement through development, testing and transfer to manufacturing and market launch" (Voss et al., 1994, p.2). Process innovation is concerned with improving existing processes and introducing new processes, that can lower production costs, improve output quality and lead to the emergence of new or enhanced products.

According to Myers and Marquis (1969, cited in Trott, 2005, p.15) "innovation is not a single action but a total process of interrelated sub-processes. It is not just the conception of a new idea, nor the *invention* of a new device, nor the development of a new market. The *process* is all these things acting in an integrated fashion." This integration does not happen by accident, but through active management. Trott (2005, p.15) defines innovation as "the management of all the activities involved in the process of idea generation, technology development, manufacturing, and marketing of a new (or improved) product, or manufacturing process, or equipment."

Innovation activities need not follow sequentially. They may be performed with some degree of overlap, by cross-functional teams, in order to shorten the development lead time. Cross-functional teams are teams of employees representing different functional disciplines and/or different process segments who tackle a specific problem or perform a specific task. An example of a cross-functional, team-based approach is concurrent engineering in which product design, and the manufacturing/assembly process are designed and configured within the same time-frame, rather than sequentially, thus considerably shortening the time taken up in the innovation process. This cross-functional approach to innovation also shortens new product development lead-time (Lynn et al., 1999). The lead-time for each new product development project is the time between the start and finish of NPD projects. Reducing the lead-time for NPD projects is an important competitive concern for innovative firms (Cooper and Kleinschmidt, 1994, Kessler and Chakrabati, 1999).

The innovation process produces an innovation, defined by the Australia Bureau of Statistics as "the introduction or implementation of a new or significantly improved good or service; operational process; organisational/managerial process; or marketing method" (Australian Bureau of Statistics, 2008a). The innovations under investigation in this study are physical products, as opposed to a new type of service, or a new process. Product innovations emerge with varying degrees of 'newness'. Rogers and Shoemaker (1971) in defining an innovation, state that "it matters little, as far as human behaviour is concerned whether or not an idea is 'objectively' new as measured by the lapse of time since its first use or discovery

….. *If the idea seems new and different to the individual, it is an innovation.*" For the purposes of this research, newness, or originality has been categorised as follows:

- True innovations: innovations that are new to the world, such as the first airplane or personal computer,
- New product lines: innovations that are new to a particular firm, allowing it access to new markets, such as Telstra providing mobile phones, or internet access,
- Product line extensions: innovations that are new to the firm but comprise part of an existing product family, such as light beer, or unleaded petrol.
- Improved products: are innovations that represent a modification to an existing product that offers improved performance to customers, such as longer life automobile tyres.

These descriptions follow the commonly accepted categorisation of new products (Crawford and Di Benedetto, 2003).

1.6.2 Performance Measurement Definitions

A performance measure can be defined as "a metric used to quantify the efficiency and/or effectiveness of an action". Performance measurement on the other hand, is "the process of quantifying the efficiency and effectiveness of action" (Neely et al., 1995). A performance measurement system can be defined as the mechanism supporting the measurement process, by which the required information is gathered, recorded, and processed (Kerssens-van Drongelen, 1999).

Traditional performance measures are those which focus on financial, aggregative types of performance measures. These would include such things as sales, gross profit, net profit, return on investment, earnings per share, earnings per employee, and the like.

Determinants-based performance measures are those that provide indications of expected outcomes so that actions may be modified to achieve desired outcomes.

Fitzgerald, Johnston et al. (1992, p.7) describe these as the measures which attempt to quantify those factors which "*determine* competitive success". They equate with key performance drivers (KPDs) which focus on the separate stages of, and are "important contributors to the outcomes of processes" (Walsh and Sinclair, 1995, p.36).

Key performance indicators are described by Walsh (1995, p.29) as "those critical measures which ultimately determine profitability and shareholder value". In the main they are measures of outcome that generally provide insufficient information with which to select appropriate actions that lead to process improvement.

1.6.3 Definitions of Survey Instrument Terms

The following terms were included in the quantitative survey instruments (Appendix 1 and 2). These definitions were also used during qualitative data collection to inform respondents as to the exact meaning of each concept.

Action programme - A major project aimed at producing considerable changes in your business unit's management practices and organisation, to which your business unit is devoting substantial resource and innovation effort, and on which is concentrated significant management focus and commitment.
Capacity utilisation - Used labour capacity (in full-time equivalents) for successfully completed projects as a percentage of total available capacity.
Collocation - Different disciplines involved in the NPD project are (temporarily) relocated to collaborate at the same physical location.
Conformance quality - The extent to which the product meets the customer's technical specifications/expectations.
Customisation capability - The ability to efficiently and quickly develop and deliver customer specific variations on existing products.
Environmentally sound products - The extent to which the product is recyclable, components can be reused, or biodegradable materials are used.
Existing products - Products last launched, improved or modified three or more years ago.

Improved products - Existing products modified within the last three years to offer improved performance to customers.

Innovativeness - The ability to efficiently and quickly develop and successfully launch new, affordable and high-quality products.

Level of modularisation - The extent to which parts, components and modules are used in different products.

Manufacturability/assembleability - The relative ease with which parts and components can be produced and assembled to complete products.

New product lines - Products, launched within the last three years, that are new to your business unit and allow you to maintain or improve your position in existing markets, or to access new markets.

Product customisation - Adapting existing products to specific customer requirements.

Product design/innovation - The look, feel, styling of the product, but also technological advance.

Product functionality - The extent to which the product meets the customer's functional specifications/expectations.

Product line extensions - Products, launched within the last three years, that are new to your business unit but added to an existing family.

Product price - Off-the-shelf price but also including e.g. life cycle cost.

Product range - The portfolio of products offered to the market place.

Time-to-market - The time between starting the development of a new product and its launch in the market place.

True innovations – Products launched within the last three years that are new to the business unit or the world.

1.7 Delimitations and Scope

Innovation management is a complex issue. The study of innovation management over the past twenty-five years has been extensive and ongoing. In order to address specific issues, narrowly focused research is essential. Innovation is necessary for organisations that wish to maintain long-term competitive advantage, but given the shrinking product life cycle brought about by rapid technological advancement, innovation is becoming increasingly important for short-term survival as well. A

key element in obtaining the most from a product's shortened life cycle is how rapidly new products can be brought to market. So the emphasis of this research is on that part of the innovation process known as new product development, which, broadly speaking covers the steps from design to manufacture.

This narrow scope more accurately reflects the perception small business has of the new product development process, and in particular small manufacturers who typically are subcontractors to larger organisations, manufacturing to specification. They may initiate process innovations, or even provide feedback to customers for subsequent product upgrades. Small manufacturers may even develop new products on their own initiatives. Where they do, this generally involves a significant commitment of resources relative to the organisation's size, so getting things right is a priority. This research concentrated on small-to-medium sized manufacturing business units of less than 200 employees. The creation of innovative services or process improvement is beyond the scope of this thesis.

In restricting the study to small to medium-sized manufacturing firms, a narrow subset of SMEs contributed to the research. These were either independent small manufacturers, or semi-autonomous business units of larger organisations that met the size criteria. The sample frame for the Australia firms was obtained from a university database and may not be representative of all manufacturing SMEs. The sample frame for the Danish firms was obtained from industry databases selecting firms with the appropriate SIC classifications.

1.8 Key Assumptions

In order to evaluate the links between new product processes and performance, a narrow range of performance dimensions were considered. These dimensions were:

- NPD project lead-time measures
- Time-to-market measures
- Design changes per project
- Successful project completions

- Sales from new products
- Cost measures

Within each dimension several specific metrics were used. The assumption is that these are valid measures with which to assess new product development performance. These measures are consistent with those used in the Product Development and Management Association (PDMA) surveys (Griffin and Page, 1996, Page, 1993) and the CIMA survey (Boer et al., 2001).

1.9 Outline of the Thesis

The thesis is presented in seven chapters. The Table of Contents provides section headings for the material covered in each chapter. This section provides a brief description of the contents of each chapter.

The chapter titled 'Introduction' sets the background for the research. The research problem is discussed and the research questions are developed. The connection between organisational strategy, new product development strategy, action programs, and performance is established. The justification for the research, methodology employed, and outline of thesis are then presented. The latter sections of the introductory chapter cover definitions, delimitations and key assumptions. Each chapter has a concluding section that summarises the main points of that chapter.

Chapters two and three deal with the literature on new product development and performance measurement respectively. Together these two chapters establish the theoretical foundation for the research. The research problem and questions are developed from the literature review.

In chapter four the research methodology and the justification for its selection are provided. Chapter five presents and analyses the quantitative data, whilst chapter six reviews and evaluates the qualitative data. A discussion of the findings and conclusions, and their implications are presented in chapter seven.

1.10 Conclusion

In this introductory chapter the background to the research has been established. The research problem, being the performance of new product development processes in small-to-medium sized businesses was identified from the literature review, and several research questions were developed. The justification for the research was explained and a brief outline of the research methodology provided. The latter parts of this introductory chapter provided definitions of key terms, the limitations of the research and provided a rationale for the choice of metrics used to assess NPD performance. The outline of the thesis indicated where and how the details of the research would be presented.

The next two chapters present a review of new product development literature and performance measurement literature on which this study is based.

Chapter 2

New Product Development

2.1 Introduction

This chapter and the one that follows, provide a review of the literature relevant to this thesis. The current chapter examines literature on new product development. The following chapter focuses on performance measurement literature and how it may be applied to evaluate new product development performance. This chapter begins with a discussion of the relevant terminology used in the literature. This includes defining what a new product is, and what activities constitute the development of new products. The literature review tracks the academic and empirical research that has been carried out in the field of new product development with a view to identifying those factors that impact on new product development performance. The bulk of prior research dealing with the new product development process examines characteristics for success in the big business environment. This research is considered with a view to examining whether the same criteria for effective new product development performance hold for small to medium sized firms.

2.2 Terminology

A new product can be defined from two perspectives, that of the user, and that of the developer. From the consumer's or user's perspective, the 'degree' of newness of a product is relative. Rogers and Shoemaker (1971, p.19) said "It matters little, as far as human behaviour is concerned, whether or not an idea is "objectively" new as measured by the lapse of time since its first use or discovery … If the idea seems new and different to the individual, it is an innovation." Crawford and di Benedetto (2003), provide a useful categorisation of new products from a developer's perspective. They include new-to-the-firm products, which though not innovations,

will require the adopting firm to put these products through their new product development process. Their new product categories are shown in Table 2.1.

Table 2.1: New Product Categories, based on Crawford & di Benedetto (2003, p.12)

Category	Description
New-to-the-world products	Products that are inventions; e.g., Polaroid cameras, the first car, rayon.
New category entries	Products that take a firm into a category new to it. Products that are not new to the world; e.g., Hallmark gift items, Procter & Gamble's first shampoo.
Additions to product lines	Products that are line extensions, flankers, etc., in the firm's current market; e.g., Kellogg's cereals, Foster's light beer.
Product improvements	Current products made better; virtually every product on the market.
Repositionings	Products that are retained for a new use or application; the classic case is Arm and Hammer baking soda, which was repositioned several times as a drain deodorant, refrigerator deodorant, etc.

Crawford and di Benedetto's taxonomy closely follows that developed by Booz, Allen, and Hamilton (1982), and constitutes the commonly accepted categories of new products.

The 'degree' of newness has implications in terms of risk, organisational capabilities and resources. The development of a 'new-to-the-world product, would involve relatively higher levels of risk, require greater commitment of resources, and draw upon cutting edge capabilities, both commercial and technological. Such new products would seem to be outside the domain of product development activities for small to medium sized firms. Nevertheless there are exceptions that can launch a small business into the big-business category, e.g., Dyson Vacuum Cleaners (Jones, 2002). Indeed, all existing big businesses started off small. Whilst innovation is one of several corporate strategies to grow a business (Ansoff, 1968, Booz et al., 1982), those other strategies that contribute to the growth of businesses, such as

mergers, acquisitions, market penetration, or market development, are not within the scope of this thesis.

Whether a business chooses to pursue incremental innovations in the form of product repositionings, product improvements, or additions to product lines, or whether it chooses to branch out into new category entries or new to the world products is a strategic decision. One of the important issues examined in this thesis is the new product development strategies that small to medium sized businesses select, and the factors that influence their choices.

This thesis will examine certain practices with regard to the development of new products. The new product development process is sometimes a subset of the broader innovation process, though many authors (Cooper and Kleinschmidt, 1986, Crawford and Di Benedetto, 2003, Trott, 2005) choose not to make this distinction, as can be seen in the subsequent definitions presented in this chapter. Rogers and Shoemaker's (1971) definition might have blurred the distinction between innovation and a new product insofar as they refer to anything new to the user as an innovation, more recent innovation management literature provides clarification. In broad terms innovation can be regarded as any practice, process, or product that is new to the user (Cooper, 1998). A new product, of whatever degree of newness, is the output of that process. Innovation in the context of this thesis refers to a management process. "Innovation is the management of all activities involved in the process of idea generation, technology development, manufacturing and marketing of a new (or improved) product or manufacturing process or equipment" (Trott, 2005).

It is important at this early stage to distinguish between process innovation and product innovation. "Process innovation usually applies to functions, especially the manufacturing or distribution process" (Crawford and Di Benedetto, 2003). Process innovation allows an organisation to do what is currently being done more efficiently, without necessarily giving rise to new products. These types of innovations tend to result in benefits to the company in terms of cost reductions, and to the consumer in terms of added value. Process innovations are often examined from a quality improvement perspective (Evans and Lindsay, 2008). Nevertheless,

as new processes expand the capabilities of organisations, they present opportunities for the development of new products. Process innovation may be incremental, in which case the management literature on continuous improvement would be relevant, or it may be radical, and dealt with under such topics as benchmarking, or business process reengineering. Reference to these fields of study will only be mentioned in this chapter insofar as they impact on product innovation, and not process innovation. Process innovation typically follows product innovation (Abernathy and Utterback, 1978). This thesis will not concern itself with process innovation per se, though at its core is the examination of the process by which new products emerge. One objective of the research is to identify the capabilities that organisations will need to cultivate in order to achieve best practice in new product development. As was discussed in section 1.8 on scope and limitations, this thesis is concerned with the activities of small to medium sized firms that contribute to the development of new products. This narrower view then focuses on what may be termed product innovation as opposed to process innovation.

The term 'product innovation' refers to the process by which new products are developed. In the context of this thesis, the broadest definition of the process will be applied. It covers "the total operation by which a new product is created and marketed, and it includes innovation in all of the functional processes" (Crawford and Di Benedetto, 2003). Product innovation covers:

- front-end activities such as market research, and concept generation and evaluation,
- development activities such as prototyping, testing, production planning and marketing, and
- commercialisation activities including distribution and sale.

The terminology used in product innovation literature can be quite varied also. Many of these terms overlap to varying degrees, and to use them interchangeably can be confusing. For instance, what is the difference between research and development (R&D), new product development (NPD), product innovation (PI), and new products management (NPM)?

The Australian Bureau of Statistics (2008b) defines research and development activity as "Systematic investigation or experimentation involving innovation or technical risk. The outcome of which is new knowledge, with or without a specific practical application, or new or improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products/processes. R&D activity ceases and pre-production begins when work is no longer experimental". Roussel et al., (1991, p.14) define industrial research as the "orderly approach to the revelation of new knowledge … [which is] applicable to a company's business needs that will enable the company to be in the forefront of new technology or lay the scientific foundation for the development of new products or processes…." They further state that, "though there is no precise demarcation between *research* and *development*, a broad distinction can be made. If the purpose of research is to develop new knowledge, the purpose of development is to apply scientific or engineering knowledge, to expand it, to connect the knowledge in one field … with that in other fields … In the general case, development seeks to move product or process concepts through a series of definite stages to prove, refine, and ready them for commercial applications." (Roussel et al., 1991, p.14) They identify three basic types of research and development, which are described it Table 2.2.

Table 2.2: Categories of Research and Development, Based on Roussel et al., (1991)

R & D Type	Description	Types of New Products
Incremental R&D: Small "r" and big "D"	Small advances in technology are made based on an established foundation of scientific and engineering knowledge.	Product families, improvements, differentiated products, next generation products, additions to product lines.
Radical R&D: Large "R" and often large "D"	Radical R&D draws on the foundations of existing scientific and engineering knowledge that is insufficient to arrive at the desired outputs. It involves the discovery of new knowledge with the explicit goal of applying that knowledge to a useful purpose.	New-to-the-world products.
Fundamental R&D: Large "R" and No "D"	The scientific/technological reach into the unknown. It has two goals: (1) to develop a depth of research competence in fields of potential future technology, and (2) to prepare for future commercial exploitation of these fields.	None, apart from perhaps published or confidential research papers, or non-commercialised prototypes.

Clearly, research is a precursor to the development of new products, though both activities are part of the innovation process as defined by Crawford and Di Benedetto (2003). The type of R&D also influences the types of new products that might emerge.

2.3 New Product Development Process

The new product development process involves a great many activities, and has been interpreted using a number of different models. Cooper and Kleinschmidt (1986) itemise the following tasks in developing new products:

- initial screening
- preliminary market assessment
- preliminary technical assessment
- detailed market study/market research
- business/financial analysis
- product development
- in-house product testing
- customer tests of products
- test market/trial sell
- trial production
- precommercialisation business analysis
- production start-up
- market launch

There is no single model that represents the new product development process. A basis for the classification of different models has been provided by Saren (1984). Saren's classification extends Cooper's (1983) empirically-based classification of the new product process, in which Cooper suggested that the construction of a generalised model is inappropriate because evidence supported the existence of several different types of innovation processes. Saren's classification is summarised in Table 2.3.

Table 2.3: Models of the New Product Development Process, Based on Saren (1984)

Types of Models	Description
Departmental-stage	The innovation moves sequentially through various departments as it advances from concept to finished product
Activity-stage	The process is described in terms of the activities undertaken to develop the new product.
Decision-stage	The process is broken down into a series of decisions. The decisions may be grouped according to the departments or activities they affect, or shown in the sequence in which they are addressed.
Conversion Process	The process is represented as a system which transforms inputs (e.g. scientific knowledge, customer needs) into outputs (new products or services)
Response Models	The process comprises the stages involved when a firm develops a response to an internal or external stimulus, which results in the adoption or rejection of an innovation.

These models provided a more complex representation of the sequential linear models of innovation that preceded them. Linear models were initially viewed as technology driven, and it was not until the late 1970 that market influences began to be recognised as significant (von Hippel, 1978). Von Hippel's research led to the emergence of a market-pull version of the linear model. Both models provided useful starting points for early studies of the innovation process.

Two additional models have emerged subsequently that reflect a more integrated and at the same time broad-based approach to product innovation. The first emerged from a study of the innovation processes of five Japanese manufacturing companies by Imai, Nonaka et al., (1985) in which they identified an holistic and overlapping approach to stage management, as opposed to the analytical and sequential approach of phased project management. The second and most recent set of descriptive models of the innovation process are referred to as network models (Hart and Baker, 1994).

The overlapping approach to stage management fits into the interactive model of innovation, that was developed by Rothweld and Zegveld (1985) and referenced by Trott (2005) as "a logically sequential, though not necessarily continuous, process

that can be divided into a series of functionally distinct but interacting and interdependent stages". Central to the interactive model are the organisational functions that transform an idea into a commercial product. These are broadly categorised as research and development, manufacturing, and marketing and sales. Feedback links within the model ensure that the information flow is not linear.

Globalisation and inter-organisational cooperation have resulted in an increasing interest in the role of new product development networks. The networking model is exemplified in Hart's and Baker's (1994) multiple convergent process that embodies parallel processing and networking in the new product development process.

Networking models represent an important watershed in our perceptions of the innovation process, and how the various activities that lead to the introduction of new products to the marketplace might be better managed. Networking models shifted the emphasis from studies of what occurred within the various functional areas in linear models, to developing an understanding of the interactions that occur between functions. Networking models 'emphasise the importance placed on the interaction (both formal and informal) within the innovation process (Trott, 2005).

Networking models also provide a sound perspective from which to view the role of SMEs in innovation management. Whereas the bulk of research into innovation management has concentrated on large organisations that controlled the entire process from idea to new product launch, the environmental conditions that have led to research into network models also opened up research into the role of SMEs. These environmental conditions include the globalisation of world markets, and the rapid escalation of new knowledge and technologies. One response has been for corporations to focus their research efforts around their core competencies, and where necessary work collaboratively with other organisations to complement their research (Prahalad and Hamel, 1990)

2.4 Critical Success Factors in New Product Development

Early research into the innovation process not only sought to build the various activities and functional responsibilities into models, it also sought to identify best practice. Best practice was linked to a firm's "ability to repeatedly commercialise successful new products" (Griffin and Page, 1996, p.479). Examples of studies that presented best practice studies are Abbie Griffin's (1997) research into new product development practices, and Robert Cooper's (1999) paper on invisible success factors in product innovation. Several important practices have been identified and the literature on these is reviewed in the remainder of this chapter. This in turn raised concerns about how best practice might be measured. The measurement aspect of innovation management is covered in the next chapter which looks at performance measurement for new product development.

2.5 Strategic Alignment of New Product Development Activities

One of the most widely cited publications on competitive strategy (Porter, 1985) stated that organisations need to be specific about their choice of strategy, and that these strategic choices should fall into one of three distinct strategic frameworks – cost leadership, differentiation or focus, or niche. Porter also said that "strategic competition can be thought of as the process of perceiving new positions that woo customers from established positions or draw new customers into the market" (Burgelman et al., 2004). Clearly, new product offerings are one method of competing strategically.

The models of innovation show us that the first step in the process revolves around the emergence of an idea. This has been described as opportunity identification, where persons within the organisation, through a process of internal and external auditing, actively search for new opportunities (Crawford and Di Benedetto, 2003). Where associations can be made with the organisation's knowledge base and sources of external knowledge genuine business opportunities might be identified (Trott, 2005). In a linear model, the source of an idea may come from the

knowledge and technologies that exist with the firm, which is characteristic of the technology-push model. This may still be the case in industries where technology is at the leading edge of knowledge, such as electronics, pharmaceuticals, and nanotechnology. Technology-push is associated will all categories of new products. It is the best way of explaining the emergence of new-to-the-world offerings. Technology-push innovation has been described as lead-the-customer new product initiatives (Baker and Sinkula, 2007), that are a prerequisite to the type of disruptive innovations that create and redefine product categories (Danneels, 2004). Nevertheless, markets need to be developed for these new products. Following on from von Hippels (1978) work, many studies have examined the role of the market in innovation (Berthon et al., 2004, Kahn, 2001, Goodrich and Aiman-Smith, 2007, Griffin and Hauser, 1993). Customer-led new product development is closely linked to incremental innovations that fall under the categories of product improvements or additions to product lines which are essential to a firm maintaining its competitive position (Baker and Sinkula, 2007). There are, however, those that argue that paying too much attention to the market can stifle more radical types of technological innovation, and have an adverse long-term impact on the firm (Prahalad and Hamel, 1990, Christensen, 2003).

For small to medium-sized manufacturing firms, a customer relationship may be at the heart of their innovation practices. Whilst many small businesses might offer innovative new products, be they physical goods or services, to consumer markets, in some form of niche capacity, manufacturing SMEs are invariably intermediaries in the value chain that satisfies end-user demand. Some manufacturing SMEs might produce a stream of new products for their customers, as for example, many toolmakers do. Specialist equipment manufacturers may also design and build new products for larger organisations that then produce a range of products for the consumer markets.

Irrespective of the driving force behind a new business opportunity, organisations are faced with a variety of options in terms of which new products ideas they might choose to pursue. The decision as to which options an organisation chooses to invest its limited resources in then becomes a strategic decision "linked to the broader business strategy of the firm"(Trott, 2005, p.350). Christensen (1999, p.214)

also stated that "the company's intended strategy and its *de facto* patterns of innovation and execution [should be] mirror images of each other." For this reason, one of the research questions examined in this thesis is the extent that new product development strategy and a firm's broader business strategy are aligned. Preliminary analysis will also be carried out on whether a closer alignment of these strategies impacts on the business unit's performance, and in what way.

2.6 Formal New Product Development Processes

In section 2.3, various models were presented that attempt to describe the range of activities that are carried out during the new product development process. That section also presented a more detailed list of the various tasks that occur during this process. These tasks themselves can be broken down into a variety of activities that might need to be undertaken either on a functional or cross-functional basis. Managing any such process will be influenced by organisational needs and resources. The literature that examines the approaches organisations take is quite diverse. Brown and Eisenhardt (1995) summarise these approaches into three broad areas, namely, rational planning, communication web, and disciplined problem solving. The rational plan approach concentrates planning activities around the business and financial performance of the product. The communication web approach deals with the effects of communication on the new product development process. The disciplined problem solving literature examined new product development from the perspective of the parties involved, and the activities that are undertaken. Needless to say, any study of business units will find elements of actions that might fit into any of those three areas.

Complex models of the new product development process have emerged from studies of large organisations. Examining the activities of small-to-medium sized firms using these models may be problematic. Nevertheless, it is to be hoped that some sort of process is followed and managed in such organisations. Research by Cooper and Kleinschmidt in the 1980s and 1990s identified a connection between a formal new product development process and successful new product outcomes (Cooper and Kleinschmidt, 1986, Cooper, 1994). Specifically, the research presented in the 1994 article identified a strong link between "*quality of execution*

and *success* for most activities." (Cooper, 1994, p.72) In the context of the article, *quality of execution* refers to "the various steps and actions which make up the innovation process" (Cooper, 1994, p.72).

Despite a strong body of evidence linking the use of a formal new product development process to successful project outcomes, empirical research indicates that many organisations do not use a formal new product development process (Griffin, 1997). When it comes to small business, some stages of the broader new product development process may not be followed. For instance, a study of strategic business units of the major Fortune 500 companies found that they "typically do not follow all the new product development activities" (Mahajan and Wind, 1992, p.136).

It may be that efforts to identify a best practice model for new product development are not practical. Several studies have found that many different processes can lead to successful outcomes (Booz et al., 1968, Booz et al., 1982, Griffin, 1997, Leseure, 2000). Nevertheless, some sort of new product development process is desirable, and the way such processes are managed would appear to have an impact on successful project outcomes.

Given the importance of properly managing new product development activities, this thesis will investigate the approach taken by managers of small businesses in this key area. The emphasis of the research will not be on specific approaches themselves, which may clearly exhibit a great diversity, but on whether a systematic approach, referred to by Cooper (1994) as "quality of execution" might have an impact on new product project outcomes.

2.7 Managing and Improving the New Product Development Process

Given that some sort of systematic approach to developing new products is desirable, it would be worthwhile obtaining an understanding of how such processes can be managed in order to improve project outcomes. The scope of an organisation's new product development process depends on its resources,

technological capabilities and core competencies. Large organisations might be capable of generating new knowledge through internal research and development, and then designing new products and the manufacturing processes that produce them. Some may even have the capability to distribute and market their own products. Such broad-based capabilities are rare in large organisations, and even rarer in small to medium sized firms. Irrespective of the size of the organisation, those responsible for managing new product development projects or even segments of the new product development process need to identify ways of improving their processes.

Early research in this area revolved around best practice studies, typically trying to identify those factors that contributed to success or failure in developing new products. These attempts to identify the variables associated with new product outcomes met with criticisms in terms of operational definitions and 'methodological ailments' (Cooper, 1979). Cooper's work did however result in the development of a conceptual descriptive model of the new product development process that provided structure to the research being carried out in the field of new product development (Cooper, 1983).

Subsequently, a number of new product models emerged and these became the subject of a study to evaluate their effectiveness (Mahajan and Wind, 1992). They surveyed strategic business units (SBUs) that were members from the Fortune 500 firms of the Product Development and Management Association (PDMA). They obtained 78 responses from 69 firms and found amongst other things that most of the SBUs do not follow all the new product development activities in the models they do use. Further, the use of new product models was not widespread. One of the major problems identified across these new product models was their forecast inaccuracy; nevertheless those who did use new product models were generally happy with them (Mahajan and Wind, 1992).

A later study conducted on behalf of the PDMA by Abbie Griffin (1997)examined new product development trends and benchmarked best practices. Best practice firms were defined as being in the top 20% against a set of six new product development metrics, namely, time-to market, time-to-profitability, project goal

attainment, NPD revenue contribution, R&D Effectiveness Index and wasted development project spending. Whilst admitting that recent studies indicated that best practices may be somewhat context-specific, the study did present some consistent findings. Principal amongst these were that the best are more likely to have NPD processes and strategies and start the NPD process with a strategy (Griffin, 1997).

Wheelwright and Clark (1992a) argue that this should be an ongoing process. They placed special emphasis on the need to strengthen core research and development capabilities. These capabilities are the result of competencies that organisations need to develop across a wide range of technical, and business processes and systems. Prahalad and Hamel (1990, p.82) describe capabilities in terms of core competencies as "the collective learning in the organisation, especially how to coordinate diverse production skills and integrate multiple streams of technologies". They further stated that "core competencies are the wellspring of new business development" and that "top management's real responsibility is a strategic architecture that guides competence building" (Prahalad and Hamel, 1990, p.91). Trott (2005, p.185) defines competencies as "knowledge, skills, management processes and routines acquired over time that are difficult to replicate".

The need to develop firm specific capabilities for competitive advantage is a relatively recent phenomenon. Caffyn, (1998) developed a model to explore the application of continuous improvement within new product development processes, based on the concept of capability development. She described a capability in innovation management as referring to how companies manage the process of innovation. Her 'Continuous Improvement Capability Model' identified six core organisational abilities and nine key behaviours that underpin successful continuous improvement in new product development. This model offered a systematic way of evaluating the maturity of behaviours that defined core abilities. By providing an environment that supported and developed desired behaviours, firms could continuously improve their innovative capability. As such it provides a road map of sorts for managers who hope to build capabilities in new product development. Caffyn's (1998) thesis also provides a valuable summary, of continuous improvement literature linked to innovation and new product development.

Another stream of literature dealing with improving new product development performance takes its origin from the seminal work of Imai, Nonaka and Takeuchi (1985). Their case-based research into five Japanese companies identified practices that accelerated product development, including overlapping development phases and cross-functional teams. The use of cross-functional teams however, was only effective if supported by continuous communication, in other words, knowledge transfer and management. Subsequently, many researchers have examined the role of knowledge in new product development. One view is that organisational knowledge as a distinctive capability is the product of a firm's structure (Kay, 1993). Another is that the knowledge base of an organisation also includes knowledge embedded in the relationships between individuals as embodied in processes and procedures. "Managers in these firms recognise that creating new knowledge is not simply a matter of processing objective information. Rather, it depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of employees" (Nonaka, 1991, p.97). These writers together propose that organisational knowledge can be attributed to both organisational structure and organisational processes and procedures, both formal and tacit.

Ray Stata, chairman of Analog Devices considered organisational learning to be the key to management innovation, and argued that "the rate at which individuals and organisations learn may become the only sustainable competitive advantage, especially in knowledge-intensive industries" (Stata, 1989, p.64). He attributed U.S. industry's declining rate of innovation to this lack of management innovation and identified leadership as a critical component for improving product development performance.

If organisational learning is seen as critical, how do organisations learn? One of the problems associated with this question is that there seems to be no agreement on the definition of organisational learning itself (Chiva and Alegre, 2005). They categorise individual learning theories into three groups: behaviourist, cognitivist, and humanist. They provide a solid overview of the literature on both organisational knowledge and organisational learning but claim that "these concepts face certain theoretical confusion arising from the ongoing theoretical debate, enhanced by the existence of different perspectives and the independent paths taken by both groups

of literature, in spite of their implicit links" (Chiva and Alegre, 2005, p.61). The predominant approach in examining organisational learning with regard to innovation management appears to be behaviourist, as exhibited in the writings of several researchers (Bartezzaghi et al., 1997, Boer et al., 2001, Caffyn, 1997, Corso, 2002). The theoretical debate referred to by Chiva and Alegra (2005) has no relevance to this thesis; what is relevant are those characteristics of the organisation's culture and environment that support learning. Johnston and Hawke (2002, p.9) defined a learning culture as "the existence of a set of attitudes, values and practices within an organisation which support and encourage a continuing process of learning for the organisation and/or its members". The implication is that certain behaviours can facilitate and support learning, and organisations need to support and develop these behaviours in order to develop a capability for learning. In examining the relevance of organisational learning for new product development, the principal concepts seem to be the understanding of knowledge and the relevance of social interactions for learning (Koners and Goffin, 2007). In terms of understanding of knowledge, they discuss explicit and tacit knowledge. They further state that tacit knowledge is "difficult to articulate", and "can only be transferred through detailed discussions among people from similar backgrounds and with common experiences" (Koners and Goffin, 2007, p.52). This conclusion connects neatly with research done by Lynn and others (1998) on the role of teams in the new product development process.

Teams provide a fertile environment for the exchange of both explicit and tacit knowledge. Lynn (1998, p.74) observed that "nowhere is team learning more critical than in new product development". In a study of new product projects he found that learning was critical to success and lacking in failures. He identified different types of team learning and developed a series of team learning mechanisms and a roadmap for team learning strategies dependent on the degree of innovativeness in a project (Lynn, 1998). Further research by Lynn and others identified a learning driven strategy, where the emphasis was not on the first step of the innovation process, but on subsequent, better informed steps, as being critical for succeed in new product development (Lynn et al., 1998). It is interesting that they concluded this learning strategy was applicable to radically new products, but in focussing on subsequent steps of the innovation process, they are describing the

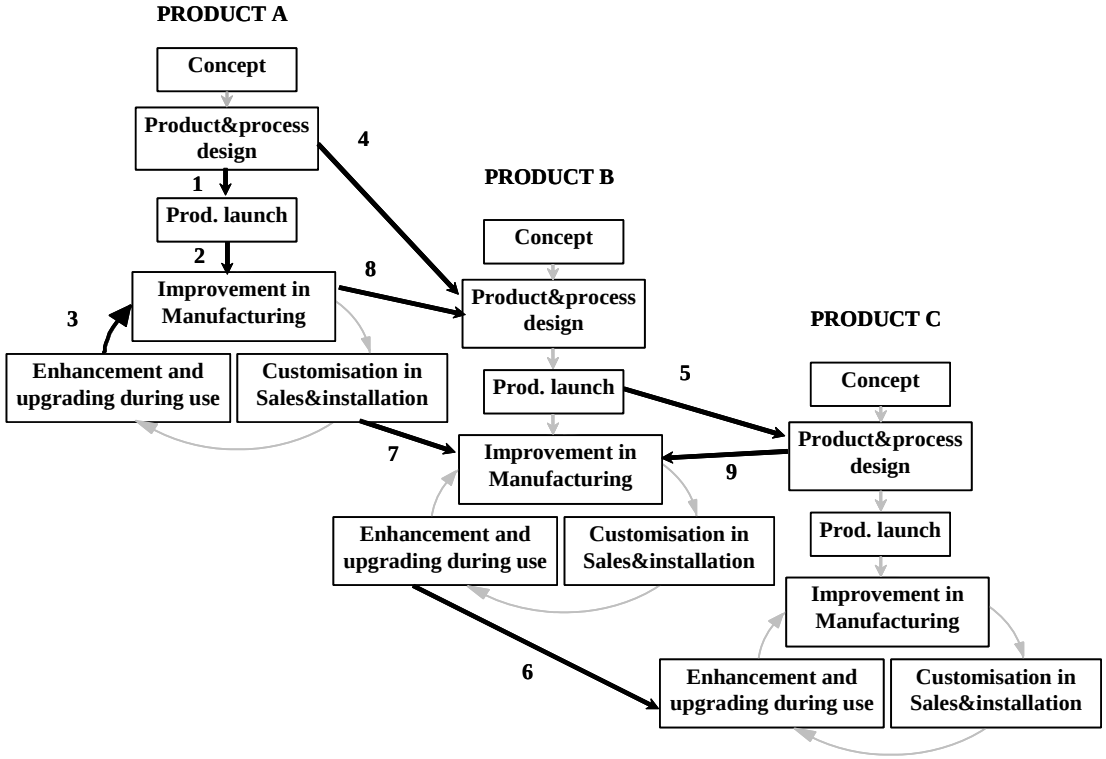
inter- and intra-project learning that is at the heart of the research Bartezzaghi and others into incremental and continuous innovation (see below, and refer to (Bartezzaghi et al., 1997, Boer et al., 2001, Corso, 2002). Lynn's research also describes a series of practices or behaviours that support team learning (Lynn et al., 1999).

The role of behaviours within organisations in building learning capabilities was examined by Caffyn. Organisations learn through a process of knowledge accumulation. In her (Caffyn, 1998, p.44, Trott, 2005) capability model, organisational learning equates to the core ability of "enabling learning to take place and to be captured and shared at all levels of the organisation." As Trott (2005, p.194) says, "The accumulation of knowledge and the effective assimilation and application of this knowledge are what appear to distinguish innovative firms from their less successful counterparts." Trott also cites several authors' contributions to the study of organisational learning, whilst commenting that none of them describe the actual activities or processes that are required.

One such interpretive model of how learning takes place during the product development process was put forward by a group of Italian researchers (Bartezzaghi et al., 1997). Figure 2.1, below shows the various opportunities for knowledge transfer and learning between and within new product development processes. Nine different types of knowledge transfer are identified. A full explanation of each type of knowledge transfer is given in their paper. Their study of nineteen Italian and Swedish firms looked at barriers to learning and means of overcoming those barriers. The study looked at inter-project learning within product families, where innovations are incremental rather than discontinuous. As such the emphasis was not so much on how new knowledge is discovered in a way traditionally associated with basic research, but in how discovered knowledge can be applied to improve future performance, especially in developing incremental innovations. Corso and Pavesi (2000) carried this research further, coining the phrase continuous product innovation, which they defined as innovating the product throughout its life cycle. The product life cycle goes beyond the new product development phase, typically covering the concept to product launch continuum, to incorporate innovation during

manufacturing and consumption (Corso and Pavesi, 2000, Corso, 2002, Chapman et al., 2001).

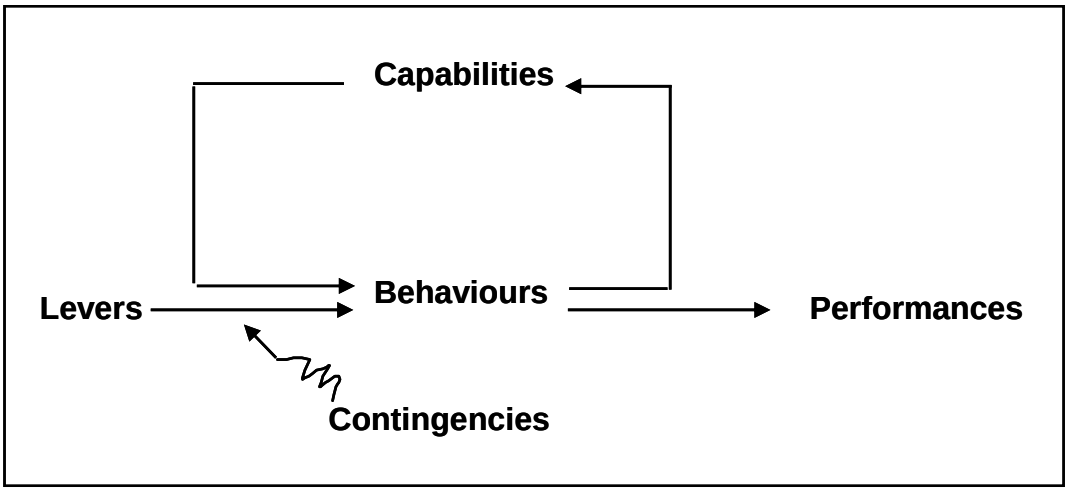
Figure 2.1: Opportunities for Knowledge Transfer within and Between Projects



Source: Adapted from Bartezzaghi, Corso et al., (1997)

The research conducted by Caffyn (1998) and Bartezzaghi, Corso and others (1997) formed the basis for a combined research project. The research project began as part of the Euro-Australian cooperation project CIMA (Continuous Improvement and Innovation Management). In its early development, the research focused on continuous improvement in new product development, influenced by Caffyn (1998). The methodology used in the research however relied heavily on the learning and knowledge transfer model (Bartezzaghi et al., 1997). The behaviours that Caffyn (1998) identified as supporting continuous improvement in new product development were incorporated in the CIMA model which has been described as a behavioural model of learning in continuous product innovation (Boer et al., 2001). The CIMA behavioural model is useful in examining learning and knowledge generation within the product innovation process in terms of a number of interrelated variables, as shown in Figure 2.2 (Boer et al., 2001, Gieskes, 2001).

Figure 2.2: Elements in the CIMA Explanatory Model for Learning in Continuous Product Innovation



The model incorporates the behaviours that underpin the capabilities necessary for successful new product development. The five capabilities identified in the model were specific to learning and knowledge management. Performance was evaluated across five dimensions in terms of improvement activities carried out in the product innovation process. Performance improvement was achieved and measured against a set of eight discrete behaviours, which could be influenced by management interventions (levers). A more detailed explanation of these variables is given in the relevant publication (Boer et al., 2001).

The two approaches to improving new product development performance discussed above, namely, building capabilities, and managing knowledge, might be seen as options or alternatives in terms of the strategic choices organisations can pursue. It may be that capability development and knowledge management are complementary and go hand in hand. However, one paper emerged in the literature review suggesting that knowledge management initiatives in the new product development process might adversely impact on capability development, or in the authors words 'expertise development practices' (Oshri et al., 2006). Their conclusions, based on a literature review, and an in-depth case study of a company in the Israeli high-tech industry, were that efforts to tap into and reuse existing firm knowledge actually had 'the unintended consequence of upsetting the past harmony between knowledge sharing and expertise development" (Oshri et al., 2006, p.79). Interestingly, the authors also describe knowledge management as an internal capability, and that

efforts to maximise the use of this internal capability might lead to a diminishing in the exploratory search for new knowledge.

2.8 Small and Medium-sized Businesses and New Product Development

Most of the published research into new product development deals with large organisations and complex processes. Whilst much of the early research examined new product development practices in large organisations, the successful introduction of new products is no less important for small business (Wynarczyk, 1997). Only recently has the literature begun to reflect this relevance. As a consequence more articles are appearing that examine new product development processes in small to medium-sized businesses (SMEs).

An investigation of new product development practices in Australian SMEs in the chemical and machinery industry found that whilst these SMEs undertake technology related activities quite well, they performed less well when it came to marketing related activities (Huang et al., 2002). They concluded that the quality of NPD activities were affected by resource availability, and the existence of a new product strategy. Perhaps one reason for a lack of attention to marketing activities could be the small business unit's position in the value chain, as a provider to larger manufacturers or retailers, which themselves concentrate on marketing related activities. SMEs in this position may employ a "craftsman-style approach to product development ... manufactured to dimensions given on a drawing" (Trott, 2005, p.400).

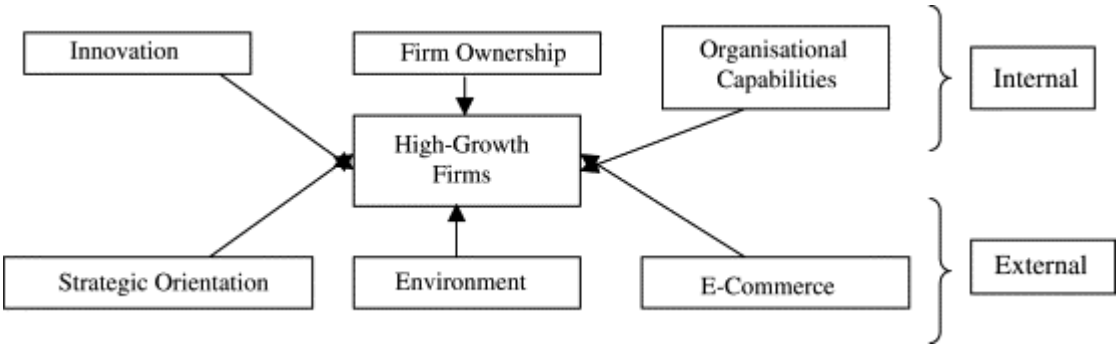
A study of industrial new product development in five Finnish SMEs focused on the role of strategy. It was found that, for these firms there tended to be a lack of long-term perspective and limited long-term planning. The success of these firms was linked to their flexibility in aligning the firm's resources with market requirements, and in having a good understanding of their customers. The conclusion was that such firms are reactive in their approach to innovation and rely on closed (incremental) new product strategies. The report concluded that such firms face the risk of being unable to identify and take advantage of business opportunities that

might arise that are outside the scope of their current product offerings (Lindman, 2002). Based on this research, SMEs with a more open strategy should be able to identify more market opportunities.

Another danger of adopting a closed strategy is that of customer dependency. The impact such a dependency might have on the new product development activities of SMEs was investigated by Raymond and St-Pierre (2004). They measured dependency in terms of the concentration of sales to the SMEs three major clients. They categorised one third of their sample (60 firms), with sales in excess of 50% of turnover to their top three customers, as being highly dependent. Where an SME works collaboratively with a larger organisation as part of a network to develop a new product, the network can provide a stimulus to innovation in the SME (Karlsson and Olsson, 1998). On the other hand, where the SMEs are merely subcontractors in a network, innovation might be a response to the more powerful customers' demands rather than creativity within the SME (Julien, 1998). In their study of 179 Canadian firms, Raymond and St-Pierre found that the highly dependent SMEs were significantly smaller in terms of turnover and number of employees and were less likely to have developed their own products, and to produce proportionally more as a subcontractor (Raymond and St-Pierre, 2004).

In a study involving 207 manufacturing SMEs throughout the United Kingdom that sought to identify drivers of high growth, both innovation and strategic orientation emerged as important variables (O'Regan et al., 2006). The study also concluded that a strategy involving investment in new product research and development and the introduction of new products, as a means of turning around poor performance, may be a more risky strategy than facilitating growth through other means. They found that many SMEs had difficulty converting research and development into effective innovation. Their conceptual model of the drivers of high growth is shown in Figure 2.3. Their findings also suggest that external attributes – strategic orientation, environment, and e-commerce – explain high growth performance in manufacturing SMEs more than internal attributes. Their research concludes with the statement "it is questionable if manufacturing firms can sustain their competitive advantage without recourse to greater research and development, and innovation in the long term" (O'Regan et al., 2006, p.39).

Figure 2.3: Conceptual Model of the Drivers of High Growth. (O'Regan et al., 2006)



A separate study carried out in England, using data provided by 95 responding manufacturing SME sought to identify the innovative characteristics of this industry sector. The study concluded that "culture, leadership, process innovation and strategic orientation were found to distinguish between more and less innovative SMMEs" (small to medium manufacturing enterprises) (Laforet and Tann, 2006, p.377). They suggested that future research of a qualitative nature might be useful in providing insights into a firm's innovative behaviour.

An important assumption that is driving the current research into innovation practice in SMEs is that they behave and perform differently to large organisations in this important area. One problem in making such comparisons is the diversity of research dealing the determinants of new product performance. In an effort to synthesise the research in this area Montoya-Weiss and Calantone (1994) conducted a literature review and meta-analysis. They identified eighteen significant factors that they grouped into four categories – strategic, development process, market environment, and organisational (Montoya-Weiss and Calantone, 1994). One observation made by the writers was that their conclusions were limited by publication bias, which at that time dealt almost exclusively research into new product development practices in large organisations. Subsequent research by McGrath (1996, reported in Ledwith et al., 2006) built on that analysis in developing a framework to explain how firms managed the three categories of variables over a product's life cycle. Whilst acknowledging the critical importance of the external market environment factors, the model chose to exclude them and concentrate on internal factors. Ledwith et al., (2006) made a comparison between the management of new product development projects in two large and two small firms using the

McGrath framework as a starting point. Data was collected from 47 interviews in four firms and analysed to adapt the framework developed by McGrath. Their research concluded substantial differences in behaviours exist between firms that can be attributed to size.

The new product development processes that were examined in section 2.3 relate to large organisations, and may have limited applicability in the small business environment, where firms might only be involved in a limited range of activities associated with the broader innovation process. Many writers point to significant differences that exist in the management of new product development activities based on firm size (Huang et al., 2002, Julien, 1998, Ledwith et al., 2006, Lindman, 2002, O'Regan et al., 2006, Raymond and St-Pierre, 2004). These differences in themselves present challenges when attempting to model innovation processes within SMEs. One group of researchers set out to investigate business modelling techniques that could be used to support and improve innovation processes within small and medium-sized enterprises (Scozzi et al., 2005). They conducted a literature review that identified problems faced by SMEs in developing new products, and followed this up with a field study involving nineteen SMEs. Their findings were inconclusive, but identified the importance of models and methods as enabling factors in managing new product development. They also identified the need for ongoing research.

2.9 Summary

The literature supports the need for ongoing investigation into the new product development practices and performance of SMEs. Important elements in distinguishing better performing organisations were identified, and these will be further explored in this thesis. The first such element is that of strategic alignment of the new product development strategy with the business unit's strategy. Many writers have investigated and verified its importance (Burgelman et al., 2004, Cooper, 1988, Crawford and Di Benedetto, 2003, Ulrich and Eppinger, 2000). The second concept that emerged from the literature review, and that will be examined in this thesis is concerned with the impact of process on new product development performance, and specifically, whether formal new product development process

has an impact on outcomes. There is widespread support for the value of a formal process in developing new products (Crawford and Di Benedetto, 2003, Griffin and Page, 1996, Saren, 1984, Trott, 2005), but little research on whether such formal processes are employed within SMEs, or even whether they are effective in terms of improving NPD performance. A third aspect of new product development to be examined in this thesis is the role of managers in influencing performance. The research of Caffyn, Bartezzaghi, Corso, Boer and others (Bartezzaghi et al., 1997, Boer et al., 2001, Caffyn, 1998) indicated that managers can intervene to develop capabilities and improve behaviours that support new product development. In this thesis, the types of interventions that might be used by managers in small businesses are examined.

This concludes the literature review dealing with innovation management and new product development. Excluded from the literature review in this chapter was material dealing with performance measurement, and how new product development processes and outcomes might be evaluated. In the next chapter literature dealing with that aspect of innovation management is examined.

Chapter 3

Performance Measurement

"Count what is countable, measure what is measurable, and what is not measurable, make measurable..."

Galileo

3.1 Introduction

In the introductory chapter the proposition was put forward that any organisation wishing to improve its new product development (NPD) processes must have a supportive performance measurement system in place. In chapter two, the literature on new product development practices was reviewed, with an emphasis on research carried out on small to medium-sized firms. This chapter examines the literature dealing with performance measurement.

The literature on performance measurement is extensive. During the 1970s and 1980s performance measurement gained wide attention as a necessary complement to continuous improvement and quality management. In the 1990s the scope of performance measurement was significantly expanded to cover a wide range of issues (Kaplan and Norton, 1992, Eccles, 1995). The expanded role of performance measurement saw a shift from largely financial measures to those concerned with quality, personnel, training, innovation, and the customer. At the same time performance measurement data was starting to be linked to an organisation's strategic objectives and becoming more focussed, in that they allowed management to better evaluate organisational performance in areas of specific importance. In other words, the performance measurement systems of such organisations were closely linked to the strategic goals of the organisation, allowing it to monitor performance and react appropriately to deviations from plan. Rather than rely on a raft of performance metrics that provided data for evaluating performance and controlling business processes, performance measures now tracked performance against strategic plans, and provided input into future planning activities.

The growing importance of and research into, the design of performance measurement systems highlighted this complex relationship between the expanded scope and tighter focus of performance metrics. The expanded scope of performance metrics provides a balance between financial and non-financial metrics that helps overcome a tendency towards short-term decision-making, and at the same time allows for collection of meaningful data across the entire spectrum of business activity. The strategic objectives of the organisation should provide a focus for managers in the selection of key performance measures from this broad suite of metrics.

The expanding scope of performance measurement raised important questions for the design of performance measurement systems. Researchers began to study how organisations could develop effective company-wide performance measurement systems (Kaplan and Norton, 1992, Kerssens-van Drongelen, 1999, Neely et al., 1995). The strategic focus of performance measurement also raises questions about what should be measured. Attached to this problem is a range of issues, including: relevancy of measures, measurement scale, responsibility for measurement, criteria for evaluating outcomes, communicating and interpreting outcomes. Several of these questions will be addressed later in this thesis. The material presented here deals with the what, why, and how of performance measurement, and concludes with a look at current practice in performance measurement in the new product development process.

3.2 Performance Measurement Defined

Performance measurement is a process of data collection and analysis that not only provides information on the effectiveness of current activities, but should also provide an objective basis for the development of strategic plans and objectives (Kaplan and Norton, 1996b). The individual variables on which data is collected are called metrics, or performance measures. Performance measurement evolved in a business environment where performance measures could be easily applied to quantifiable outputs, such as the number of units of an item produced over a given time period. The profitability of a process could be evaluated by subtracting the cost of inputs from the value of outputs, or by dividing the value of outputs by the

value of inputs to obtain a standardised profitability ratio for comparison over different time periods. The efficiency of a process could be measured by comparing the time taken to produce a given volume of output to an accepted standard time for the process. These types of measures are all internally focused. They tell an organisation little about how to improve its processes, or how the company is performing relative to its competitors, or whether or not it is meeting its customers expectations. Performance outcomes were generally reported in financial terms for the information of senior managers, shareholders and external stakeholders such as suppliers, investors, and lenders. These characteristics define what will subsequently be referred to in this thesis as 'the traditional performance measurement system'. Further, these reported performance measures were aggregated and generally available after the activities they reported on had been completed. They lacked the detail necessary for day-to-day management, or efficient fine-tuning of business processes. In an increasingly competitive global marketplace, issues such as these became critical to the organisation's survival.

Competitive pressures have forced organisations to evaluate the processes they used to produce their goods and/or services. This in turn required them to re-evaluate their performance measurement systems and the types of metrics they used to assess their performance. Performance metrics that evaluate outputs are generally inadequate for assessing process efficiency, and provide little in the way of direction to managers for performance improvement. Perhaps one of the most important drivers of change for traditional performance measurement systems was increasing competition from foreign producers in the face of market deregulation. Gordon and Narayanan (1984) had noted that traditional accounting measures were more appropriate where the competitive environment was less uncertain. As well, Dixon, Nanni and Vollmann (1990, p.130) observed, "both the literature and the data analysis indicate that if market stability is changing, the relative use of financial-based measures needs to change accordingly". Further, the emergence of management approaches such as Total Quality Management and Six Sigma has resulted in an increasingly more widespread and critical use of performance measures (Evans and Lindsay, 2008).

The 1990's saw a heavy emphasis on the design of performance measurement systems. Many of the approaches to the design of performance measurement systems are described in section 3.4 (Kaplan and Norton, 1992, Nanni et al., 1992, Neely et al., 1995). Common requirements are the need to integrate measurement activities throughout the organisation and to link these with strategic objectives. The basic expression of this idea can be seen in Dixon, Nanni, and Vollmann's (1990) strategy, action and measures triangle. Placed within the manufacturing environment, it emphasises the need to link each strategic objective to a measure or group of measures, and implement the strategy with a course of action or actions such as Just-in-Time (JIT), Total Quality Control (TQC), Materials Requirement Planning (MRP) or others (Dixon et al., 1990). In all instances, the emphasis is on developing a measurement system and a strategy that supports performance improvement throughout the organisation, rather than on simply measuring performance for control and reporting.

Another strong influence on the development of performance measurement has been the growing emphasis on quality. Traditionally, measures would have been kept on the level of unsatisfactory output, in the days when the emphasis of quality was on error detection and rectification. In 1931 Dr Walter Shewhart raised quality control to a new level with the publication of *The Economic Control of Manufactured Products* which operationalised the use of statistical process control techniques (Shewhart, 1931). The focus was then on specifications or quality standards, with a consequent shift in performance measurement to statistical methods and process performance. The emphasis on measurement was very much internal. Performance measurement was however beginning to become more systematic, and there was a shift towards process improvement, through control of variation. Such performance measurement was however very narrowly targeted towards manufacturing operations.

The next stage in the evolution of the quality movement was the introduction of quality assurance that saw the emergence of quality systems based on international standards such as ISO9000 (or its local predecessors such as AS3900 in Australia). Quality assurance also involved quality planning for strategic focus, and much has been made of the need to link performance measurement to strategic objectives

(Dixon et al., 1990, Fitzgerald et al., 1992, Kaplan and Norton, 1992, Kaplan and Norton, 1996a, Neely et al., 1995). Quality assurance also placed emphasis on quality costing and problem solving, both of which require more detailed and different types of performance metrics to those that were traditionally employed by organisations. Quality assurance saw a widening of the responsibility for quality to include functions other than direct operations (Slack, 1994). As quality concerns spread throughout an organisation, so too did the need to develop performance measures with a quality focus.

The current emphasis on quality is embodied in the philosophy of total quality management (TQM), which is an organisation-wide approach to meeting the needs and expectations of customers. Total quality management is about developing a continuous process of improvement for all aspects of a business, including operations, after-sales service, quality, and customer satisfaction. The total quality management approach to continuous improvement involves "making decisions based on data, looking for root causes of problems, and seeking permanent solutions instead of relying on quick fixes" (Scholtes, 1992). It also necessitates the development of systems and procedures that support quality and continuous improvement, including, an organisation-wide, strategically focused, performance measurement system. TQM saw the development of performance measures that addressed customer needs and expectations. At the same time it placed the performance spotlight on areas of the organisation not previously subjected to detailed scrutiny. In particular, great attention is being placed on product innovation. These developments are discussed in section 3.5, following a review of the why and how of performance measurement.

3.3 Why Measure Performance

Performance measurement is about gathering data and converting it into useful information. This information is used in a variety of ways: to evaluate performance; as a predictor for planning; to determine suitable rewards (or sanctions); to support decision making; and many others. These are, if you like, reactive outcomes of performance measurement, where the data is presented in the form of standardised reports that are then employed in subsequent decision making processes.

Performance measurement can also be proactive, in terms of motivating and encouraging desirable behaviours on the part of employees. Whether the emphasis is on reactive or proactive performance measurement outcomes, choosing and using appropriate performance measures is essential for an organisation's ongoing success.

Bonsdorff and Andersin (1995) list the following functions of a performance measurement system:

1. To motivate employees
2. To demonstrate employees' contributions to organisational performance
3. To communicate performance expectations
4. To identify performance gaps and
5. To support decision making

These functions can be variously applied to individuals, departments, business units, and entire organisations. The first two functions specifically see employees as the targets of performance measurement. Pritchard (1990) developed his ProMES performance measurement system principally as a tool to motivate employees in achieving desired corporate goals. He adopts a behavioural approach and regards performance feedback as a powerful and positive motivational tool. At the level of the individual employee, performance measurement becomes more complex, both in terms of identifying appropriate measures and acceptable performance criteria, and in the desired outcome. Landy and Farr (1983) have suggested three reasons for measuring the performance of individuals:

1. <u>administrative</u>, including determining promotions and demotions, merit payments, training program assignments.
2. <u>guidance and counselling</u>, including supervisory feedback and career planning aimed at improving job satisfaction and worker motivation by providing information on current performance and probable future positions in the organisation
3. <u>research</u>, such as validation of selection procedures, evaluation of training programs, compensation plans or job enrichment programs.

The impact of performance measurement on individuals is relevant to those organisations that seek to improve their new product development processes via behavioural and learning models of the type presented in the previous chapter.

The third of Bonsdorff and Andersin's (1995) functions, communicating performance expectations, applies to all personnel who have responsibility for achieving defined objectives. Performance metrics of this type are even of value to external stakeholders and potential investors. Internally, the performance expectations created by these metrics provide goals against which managers can measure progress. Externally, the metrics provide a guide to the organisation's income and profit expectations that can be used in valuing a firm for investment purposes.

The fourth of Bonsdorff and Andersin's (1995) functions, identifying performance gaps, is perhaps the oldest and best-established use of performance measurement. It fits well with the traditional control function of management, where performance data are used on a day-to-day (though generally less regular) basis to evaluate performance against established targets, and allow for intervention action where necessary. Using performance measurement to identify variation from expected outcomes can be applied to products, processes, individuals or the organisation as a whole.

The fifth function, supporting decision-making has several aspects. Firstly, the process of performance measurement that identifies performance gaps may also provide data as to the most appropriate course of action to remedy the position. Secondly, the measurement data may be used proactively to continuously improve products and processes. Thirdly, the performance data may be used to provide strategic direction for the organisation. Whilst it is generally agreed that an organisation's strategic direction should determine which performance measures are relevant, the feedback from measurement has been explicitly recognised in overcoming a "serious deficiency in traditional management systems: their inability to link a company's long-term strategy with its short-term actions" (Kaplan and Norton, 1996b, p.75).

Another set of performance measurement functions was provided by Park et al., (1996, p.3) who argue that the functions of a performance measurement system should be:

1. to characterise so as to gain an understanding of processes, products, resources and environments, and to establish baselines for comparisons with future assessments
2. to evaluate and to determine status with respect to plan
3. to predict and thus enable planning
4. to support improvement by a) gathering information that helps to identify problems, and b) by planning and tracking improvement efforts.

The categorisation provided by Park et al., (1996), adopts a more functional approach to performance measurement, where data feeds directly into the three well-recognised managerial activities of planning, control and improvement. These functions would fit in with the last three listed by Bonsdorff and Andersin (1995), and contain none of the motivational aspect of performance measurement. It may be that in the less structured area of new product development, where uniqueness is often a feature, motivational performance measures are more important than control measures, which rely on standardised processes as a basis for measuring performance. Kerssens-van Drongelen (1999, p.191) found substantive support for four functions for measurement in research and development (R&D) namely providing insights to managers, fuelling learning, providing insights to staff, and justification of existence, decisions and performance. In case study research carried out in five SMEs, Chapman and O'Mara (2001) found that whilst this data might be used to evaluate product innovation performance, the firms were not using performance measurement data to encourage learning as a means of improving their NPD processes.

The impact of performance measurement on the behaviour of individuals has been noted by many writers (Flamholtz, 1996, Kaplan, 1984, Neely et al., 1995). For this reason it is important to ensure that a performance measurement system and specific performance metrics encourage those behaviours that align with the organisation's strategic goals. The use of performance measures in encouraging and evaluating,

improvement in new product development performance is one of the issues that will be examined empirically in this thesis.

3.4 Design of Performance Measurement Systems

Knowing why an organisation gathers performance measurement data does not necessarily mean that managers will use the data effectively. Therefore, linking performance measurement to strategic objectives is essential (Kaplan and Norton, 1992). To be effective, the data must be used to encourage and motivate the behaviour of individuals towards the achievement of corporate goals, and this can only be achieved through good performance measurement system design.

An extensive review of the literature relating to performance measurement system design was undertaken by Neely, et al., (1995). It not only provides a valuable reference work for the field of performance measurement but also posed many as yet unanswered questions. One of the findings of Neely et al., (1995, p.93) was that "managers find it relatively easy to decide what they should be measuring". In fact, many found it too easy to list a great many measures. Unfortunately, with so much data available, the types of measures that organisations might employ could include many which may signal false alarms (Dixon et al., 1990). Dixon et al., (1990) define a false alarm as one where the wrong performance measure motivates a manager. This could result in unnecessary and/or inappropriate action on the part of the manager. Other inappropriate performance measures would initiate conflicting responses from department managers when they are not aligned with the organisation's strategic objectives (Starcher, 1992). Finally, there could be an overlap in information conveyed by a multiplicity of performance measures, many of which are redundant and serve only to add to the managerial workload. Research addressing these, and other related problems led to the development of a number of approaches to performance measurement system design during the 1990s.

One of the best known of these is Kaplan and Norton's (1992) Balanced Scorecard. Their measurement system consisted of four clusters of metrics that could be used to evaluate the impact of company strategy. The four perspectives in their model were

financial, customer, internal business, and learning and growth. Their system was designed to address what they perceived as the excessive influence of short-term financial measures on the decisions of management. The process used to decide on relevant performance metrics was top-down, to ensure alignment of metrics with strategic objectives. At lower levels within an organisation (functional or departmental) such a system of measurement could aid managers in justifying actions that, in the short-term were not profit-maximising. This is an important consideration in new product development activities, where outcomes are uncertain, time-frames longer, and where short-term financial considerations should not figure too heavily in the decision making process. Were managers to rely solely on financial performance metrics, investment in developing new products could be jeopardised.

Cross and Lynch (1992) also proposed a top-down approach for developing a performance measurement system. Their performance pyramid contained nine clusters of metrics that are derived from the corporate vision and spread over three levels:

- business unit level, containing market and financial clusters
- core business process level, containing customer satisfaction, flexibility and productivity clusters, and
- department/group/team level, containing quality, delivery, cycle time, and waste clusters.

Whilst the clusters of metrics are geared more towards a production or service environment, the actual process by which the metrics are determined could be used to devise performance measures for a new product development (NPD) process. Using the Cross and Lynch methodology, senior management selects a core business process (for example, new product development) and then uses a team-based approach to develop appropriate performance measures against the categories listed above for each level of activity.

A different top-down approach to performance measurement was developed in the software design environment by Park et al., (1996). Their approach was to derive metrics from general business goals. The objective of the metrics thus developed

was to support decision-making in the various design stages. Such a process fits in well with the cross-functional stage-gate model for developing new products. The stage-gate model was found to be the most popular method of managing new product projects in United States' firms (Griffin, 1997). Griffin's (1997) report dealing with data from the 1995 Product Development and Management Association's survey found that nearly 60% of US firms (from 383 respondents) use a cross-functional stage-gate process for NPD.

Alternatives to these top-down approaches were reviewed by Kerssens-van Drongelen (1999). She describes a horizontal approach to performance measurement system design where all metrics have a causal relationship with customer requirements. The methodology for developing performance metrics involves the translation of customer requirements into required final product characteristics using quality function deployment tools (Griffin and Hauser, 1993). Such an outward looking approach to developing performance metrics would have advantages when applied to new product development activities where a superior product, in terms of meeting or exceeding customer expectations, is an important ingredient for success (Cooper and Kleinschmidt, 1987, Griffin and Hauser, 1993).

A second horizontal approach mentioned by Kerssens-van Drongelen is the system/process models approach. In this instance the measurements have an internal focus. The metrics are derived from four clusters of identified information needs that are deemed essential to control a process, or sub-process. The four information clusters are input information, process information, output information and effect information. Such an approach might be useful in terms of process control and optimisation, but is inappropriate for new product development processes from a number of perspectives. Firstly, it places insufficient emphasis on external, customer requirements. Secondly, its emphasis on control does not sit well with the flexibility required in developing new products. Finally, the output and effect information derived from developing new products may be substantially lagged, and therefore of limited use, especially in terms of feedback for process improvement. Both the horizontal performance measurement systems discussed by Kerssens-van Drongelen (1999) are taken from the work of Kerklaan, et al., (1994), but since this work is not available in an English version, the secondary source has

been relied on. The discussion on the applicability of both systems in the new product development environment is solely the work of the writer.

A bottom-up procedure for performance measurement system design is Pritchard's (1990) ProMES system. Under this system, performance metrics are developed by the employees who are responsible for a given process or product. The performance measures they develop are then validated by management to ensure that they are aligned with the organisation's strategic objectives. Such a process for designing a performance measurement system sits well with a total quality management approach and employee empowerment aspects of total quality management in particular. The problem with a bottom-up approach to performance measurement system design is that it could lack cross-functional integration. Thus, whilst individual business units might achieve local optimums, the organisation as a whole might not achieve a global optimum in terms of performance and profit improvement from its performance measurement system (Lockamy and Cox, 1994). The strategic significance of new products, their impact on profitability, and the cross-functional coordination needed to develop them all suggest that a narrowly focused bottom-up approach to performance measurement system design would be inappropriate.

The options available when it comes to performance measurement system design are considerable, as the above examples illustrate. They represent a cross-section of possible methodologies that organisations might wish to employ. The important point is that the design of a performance measurement system should be systematic. Its output should meet the needs of the organisation, and all those within the organisation that rely on its data for decision-making purposes. These outputs can function at many levels: aggregative for senior management, functional for divisional managers, or targeted for process managers and operators. The purposes underlying the development of performance measures should be strategically linked in order to ensure an alignment with the organisation's strategic objectives. This alignment with strategy is essential because performance measures influence what people do (Neely et al., 1995). The ability of performance measurement to influence behaviours presents opportunities for managers who wish to improve their new product development processes. What people do, that is, how they behave, and

which behaviours are important in new product development were discussed in Chapter 2, section 7.

3.5 Performance Measurement for Product Innovation

In this section, the literature on performance measurement relating to new product development is discussed. The term 'product innovation' refers to the process by which new products are developed. In the context of this thesis, the broadest definition of the process will be applied. It covers all activities and decisions from the time when an idea is generated (from whatever source) until the product is commercialised (i.e. launched onto the market). The various NPD processes are explained in Hart (1994, p.82) and are based on earlier work done by Booz, Allen and Hamilton (1982). This includes research and development activities that occur at the start of the product innovation process; new product development activities, dealing with production of the new product; and commercialisation activities that deal with distribution and sales. It does not include after-sales service of new products.

It is evident from the previous sections that procedures for developing effective, broad-based performance measurement systems received a great deal of attention during the 1990s. Placing the performance spotlight on the product innovation process is an equally recent activity. It is true that there are earlier examples in the literature of individual organisations using measurement criteria to evaluate their research and development activities (e.g., Hardingham, 1970, Patterson, 1983), but there is little evidence of the widespread use of performance measurement in product innovation processes.

Performance measurement within the innovation process has long been in the 'too-hard' basket (Brown and Svenson, 1988, Brown and Gobeli, 1992, Roussel et al., 1991), and some writers have suggested that developing a set of performance measures that would be relevant to all firms, or even a group of firms would be presumptuous. For example, Werner and Souder (1997, p.34) observed that "R&D effectiveness measurement methods are so individually varied and uniquely

designed for particular situations that they almost defy systematic classification". Recognising such difficulties in measuring new product development effectiveness however, should not lead organisations to abandon their efforts. As Walter Robb, senior vice president for corporate research and development at General Electric stated: "It's one thing to recognise that all measurements of research are imperfect. But it's quite another thing to say that because they are imperfect, we shouldn't measure at all" (Robb, 1991, p.16).

One early study of performance measurement of new product development (Richardson and Gordon, 1980) concluded that traditional performance measures, that is, financially-based performance measures, actually inhibited innovation. Their research involved in-depth case studies in 15 Canadian manufacturing firms. The adverse impact of financially based performance measures on product innovation could be attributed to two causes. Firstly, traditional performance measures tend to be aggregative, and focus on the organisation as a whole, rather than on individual products. As a result, the value of new products to the organisation's overall profitability is not fully appreciated. Secondly, traditional performance measures look for short-term payback and tend to undervalue new product development projects with relatively longer return periods. This is hardly surprising given the high level of new product failures (Booz et al., 1968, Booz et al., 1982). On the other hand, whilst a focus on the firm's overall performance may be detrimental to new product development activities, actual new product development success has been positively linked to a firm's overall performance (Hart, 1996). This is logical given the up-front investment required in developing new products. Organisations with the financial resources to pursue potentially profitable new products can also survive the more frequent failures. It would be misleading however to assume that successful overall performance equates to successful new product development performance. It may well be that such organisations are able to sustain a greater number of failures until they eventually generate a few winning products. Thus, whilst overall business success may be a positive factor for success in new product development and innovation, it may also contribute to inefficient new product development processes by hiding process inadequacies under the organisations overall performance. Whilst this conclusion points to a clear need to use targeted performance measures to improve new product

development processes, the development of such performance metrics has been slow in coming, either because of the difficulties in constructing such measures, or the lack of faith in those that have been developed.

In the earlier part of this chapter, mention was made of the shift from traditional, financially-based aggregative measures of performance to those that are more strategically focused (Dixon et al., 1990, Kaplan and Norton, 1992, Kaplan and Norton, 1996b, Neely et al., 1995). In response to competitive pressures, issues concerning quality and customer requirements became more important, and the performance measurement spotlight shifted to them (Fitzgerald et al., 1992, Scholtes, 1992). Indeed these issues still attract considerable attention from a performance measurement perspective (Flynn et al., 1994, Motwani, 2001, Zeitz et al., 1997). There is a growing recognition of the importance of new product development in achieving business outcomes such as: competitive advantage (Cooper and Kleinschmidt, 1996b); higher levels of profitability (Serwer, 1994); and long-term survival (Tushman and O'Reilly, 1997). This recognition is driving the search for more effective methods by which managers can improve this critical activity.

In some respects the development of performance measures for product innovation has been evolutionary. A review of the literature on the development of performance measures seems to follow a path that reflects Park et al's (1996) performance measurement functions. Initially performance measures were used to gain an understanding of processes, products, resources and environments. Later this data was used to establish baselines for comparisons with future assessments. Such performance measures were largely financially based, and used to manage marketing strategies and control operations (Johnson and Kaplan, 1987). In Park et al's (1996) taxonomy, performance measures were used to characterise the process, and evaluate performance with respect to plan.

Early academic research into product innovation practices and performance seems to have followed a similar path. Past studies of new product development performance, and efforts to improve it, concentrated on identifying those practices that successful companies employ to achieve their results. Perhaps the most widely

quoted of these early studies are those of Booz, Allen and3 Hamilton (1968, Booz et al., 1982). These studies provided a baseline for comparisons against future assessments, though their relevance to current product innovation practices has been questioned in the light of environmental changes impacting on new product development (Page, 1993). The successors to the Booz, Allen and Hamilton studies were those conducted by the Product Development and Management Association (PDMA) in 1990 and 1995. These studies were designed to "establish the levels of new product performance and success and failure as well as an examination of good or best practice in the new products field" (Page, 1993, p.273). The studies were confined to North American firms. Best practice studies are invaluable as barometers of NPD performance in the aggregate, and they do point to success factors that may be selectively applied by individual organisations in an attempt to improve their own NPD performance, but there is no guarantee that such an outcome will eventuate. Indeed, one of Page's (1993) conclusions from his analysis was that best practice is context specific. Such studies are not designed to provide insights in terms of implementing successful conditions for use in other organisations. Nor do they provide guidance in terms of appropriate performance measures that organisations might use to assess and improve NPD performance. The benchmarking data they gather, and the opportunities for further research they expose, provides ample justification for such broad-based surveys.

The third of Park's (1996) performance measurement functions was "to predict and thus enable planning". For new product development projects, the performance measures employed are largely financial. For products with a stable demand, predicting future sales, and planning productive capacity, capital investment, and other resource requirements is relatively low risk when compared with trying to make predictions for the similar requirements for new products, especially the more innovative new products. For such products, there are usually no reliable past performance measures on which to base your plans, especially not in terms of the expected demand for the new products, on which those plans must be based. Nevertheless, such projections must be made in order to develop a business plan for the new product. This business plan then provides the marker against which the success or failure of the product can be subsequently assessed. For new products, predicting and planning, becomes forecasting and planning, with a higher degree of

risk. The performance measures are largely financial, and used ex-post to evaluate whether or not the new product was a success or failure.

In the 1990 PDMA survey, data from 189 companies provided the following:

Table 3.1: Criteria Used to Measure New Product Performance

Financial Criteria Used to Measure the Performance of New Products	Percentage
Return on Investment	23.3
Various Profit margin returns	20.6
Sales and Sales Growth[1]	20.6
Various profit measures	16.4
Payback and payback period	8.5
Internal rate of return	8.5
ROA, ROE, and ROCE	8.5
Breakeven and breakeven point	5.3
Share and market share[2]	4.8
Return on sales	3.2
Net present value	2.6
Other financial measures	16.9
Non-financial Criteria Used to Measure the Performance of New Products	
Sales performance of new products[1]	30.7
Market share achieved[2]	24.7
Satisfy customer needs	21.2
Other marketing related benefits	18.5
Strategic issues/fit/synergy	13.2
Technical aspects/performance	9.0
Uniqueness of the new products	1.6
Other non-financial factors	10.6

(from Page, 1993, p.282)

Evidently, some respondents felt sales and market share measures were financial, whilst others categorised them as non-financial, possibly dependent on whether they reported the measures in dollar or percentage terms. In any event, the percentages are based on dollar values. Clearly, the majority of measures are financially based, with the two largest, aggregated performance metrics being Sales[1] with 51.3%, and Market Share[2] with 29.5% of respondents using them. From Table 3.1 it is evident that very few if any of the criteria used to measure new product performance concentrate on the NPD process itself. This is somewhat ominous given that in the same study, when respondents were asked to list obstacles to successful new product development, the one that headed the list, in 28.6 percent of companies was "activities within the new product development process" (Page, 1993, p.283).

The last of Park et al's (1996, p.3) performance measurement functions was "to support improvement by a) gathering information that helps to identify problems, and b) by planning and tracking improvement efforts". Only within the last decade have academics and practitioners made serious attempt to employ performance measures in this way to try and improve their new product development processes.

The approaches taken to NPD process improvement have followed two broad streams. The first is operationally-based, with particular emphasis on development lead time (Griffin, 1993). The second is behaviourally-based, with particular emphasis on the human factor and how people impact on NPD process efficiency. Key issues for the behavioural approach are project champions (Page, 1993), cross-functional teams (Lynn et al., 1998, Lynn et al., 1999), and learning and knowledge management (Boer et al., 2001).

Process efficiency, and in particular reducing product development time, is an important ingredient of new product success (Rosenau, 1988, Wheelwright and Clark, 1992b, Kessler and Chakrabati, 1999). Further, product life cycles are shrinking (Rosenau, 1988, Griffin, 1993), so the faster a new product can be brought to market, the sooner it can start to generate revenue. In order to assess reductions in product development cycle time, performance metrics that target the various stages of the NPD process need to be developed. The 1990 PDMA survey reported an average period of 35.4 months to develop the more innovative types of new products. In their 1995 survey, this figure was down by one-third to 23.8 months (Griffin, 1997). The accuracy of these figures depends on being able to establish reliable product development cycle time baselines. Further, without accurate baseline figures, the effect of any improvement efforts on cycle time reduction would be difficult to gauge. Even then a cycle time reduction could only be considered effective if the associated product were successful in the marketplace. There is nothing to be gained from rushing a product to market that has quality defects or fails to satisfy the customers' expectations. "The objective of changing product development processes must be to decrease development time to market, while (at a minimum) not decreasing the product's probability of success in the marketplace" (Griffin, 1993, p.113). In measuring cycle time reductions then, it is perhaps appropriate to compare successful products, or failed products, but not all

product launches, when assessing reductions in product cycle time. A second issue that can cloud effective comparison in cycle time reductions is product "newness". A totally new product such as the first version of Windows, would have a longer development cycle time than subsequent upgrades, where the 'new upgrade' product uses much of the previous version's developments. The question to be asked is whether cycle time reductions are due to process improvement through learning, or simply the benefits that derive from needing to carry out less original development work. A third problem in evaluating cycle time reductions is in determining exactly what time frames are measured. Whilst there is general agreement that cycle time covers the period from conception to production, "it is unclear whether conception occurs when the need for a product change is identified, or when the solution to the need is posited" (Griffin, 1993, p.114). As a result, accurate measurement of the product development cycle time metric requires measurement of a great many variables. Those identified by Griffin (1993) are shown in Table 3.2.

Table 3.2: Summary of Cycle Time Measurement Variables

Project characteristics
- **Complexity**
- Amount of Change

Outcome Variables
- Process
  - Time through each phase
  - Cost of Development
- Product
  - Commercial success
  - Customer satisfaction

Development process variables
- Strategic driver of development
  - Deliver customer needs
  - Competitive reaction
  - Technology-driven
  - Management edict
- Type of process used
  - No process used
  - Phase review process
  - Quality function deployment
  - Stage gate
- Organisational variables
  - Organisational structure
  - Cross-functional teams
  - Co-location of team members
  - Project leader champion
- Tools and techniques used
  - Number, type and timing of market research projects
  - Computer-aided design, computer-aided engineering
  - Design for manufacturability
  - Design for assembly
  - Computer-integrated manufacturing

(from Griffin, 1993, p.116)

Table 3.1 listed a range of largely financial performance metrics that were used to measure new product performance. These measures reflected the outcomes of the new product process and did not measure the effectiveness of the process with which the new products were developed. In Table 3.2, the process itself is the subject of measurement via the aggregate metric of product development cycle time. This metric is subject to a great many contingent variables that must also be measured if accurate longitudinal comparisons are to be made to evaluate the effect of improvement efforts. These contingent variables reveal some of the complexity associated with studies of new product development. The characteristics of each new product, and the way in which it is developed create challenges for researchers and practitioners alike when it comes to measuring and evaluating new product performance, particularly when it comes to taking action to improve the new product development process.

Much of the research into new product success and failure is directed towards identifying those activities that contribute to the success of the new product. Those activities themselves however do not appear to be evaluated, at least in the context of NPD performance. Contributing factors to product success previously mentioned are a product champion, cross-functional teams, and learning and knowledge management. One strategic approach to improving new product success involves reducing product development time (Curtis and Ellis, 1998, Lynn et al., 1999). Measuring improvement requires complex analysis of the specific new product project, where each new product differs in terms of newness and complexity (Griffin, 1993). These criteria in turn affect measured outcomes in development time. This change in emphasis in measuring new product performance from the product to the process is not intended to replace the types of performance measures listed in Table 3.1. Instead, the focus on the process reflects efforts to come to grips with the complexities surrounding new product development.

As previously mentioned, efforts to measure and evaluate the NPD process can be broadly divided into the operational and the behavioural schools. Those following the operational path adopt an approach common in manufacturing and quality improvement processes. In such cases performance measures are developed for the

process inputs, its various steps, and its outputs. In the case of a new product, the process can be broken down into:

- "characteristics inherent in the project (inputs);
- variables associated with the development process; and
- measures of process and product outcomes (outputs)" (Griffin, 1993, p.115).

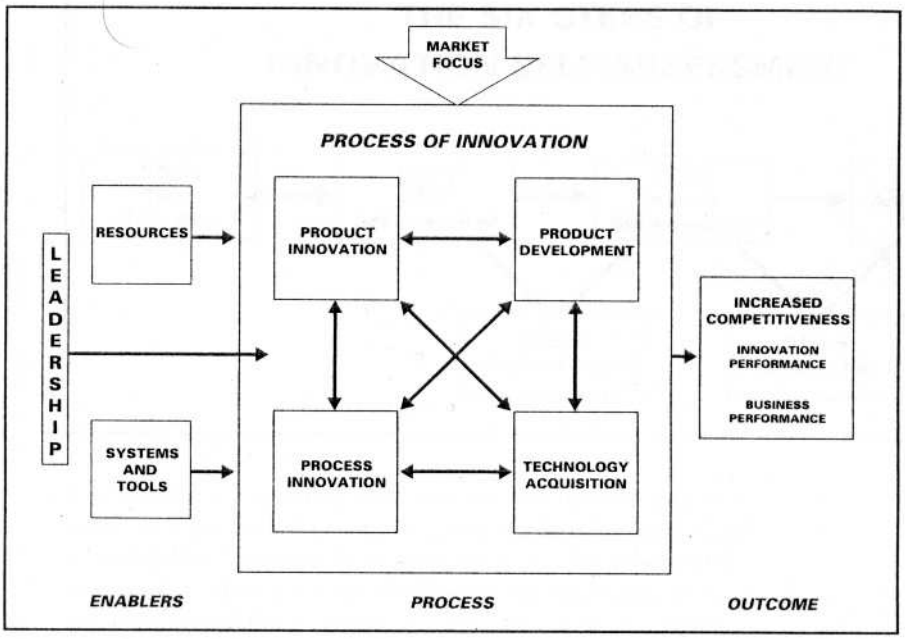
Initially, most of the performance metrics for product development concentrated on the last grouping of the three. Subsequently, with recognition of the importance of reducing development time, researchers have worked to develop performance metrics for the early stages of the NPD process. These stages, opportunity identification, concept development, product design, and process design, are covered in detail in the chapter on the new product development process.

Performance measures that focus on the new product development process have also received attention, but the variety and complexity of new products and the associated paths of their development creates challenges for measurement and comparison. Both are essential, if positive improvement actions are to be recognised and incorporated in subsequent new product development projects. Recent efforts in measuring and improving new product development performance have concentrated on the behaviours of individuals and groups associated with developing new products. Bridging the gap between the operational and the behavioural approach to evaluating NPD performance is Caffyn's work on the application of continuous improvement (CI) to the process of new product development (Caffyn, 1996, Caffyn, 1997, Caffyn, 1998). Her approach to measuring performance improvement in the new product development process requires measurement of the level of maturity of key behaviours. The assumption is that higher levels of maturity of these behaviours equates to improved performance. Caffyn does qualify the sensitivity, or rather lack of sensitivity in her maturity model, observing that "when a firm is at a more advanced level of CI maturity …. it may be harder to state with confidence the improvement made by CI to improved performance" (Caffyn, 1998, p.62). The value of the Caffyn model lies not only in its effort to establish a causal relationship between a set of generic behaviours and

the performance of the new product development process, but also in its attempt to set up a measurement scale for those behaviours.

Another procedure in measuring new product development performance is the technical innovation audit (Chiesa et al., 1996). This too goes beyond the study of best practice and innovation performance, and explores the processes used to develop and exploit innovations. "Their auditing methodology goes beyond performance measurement by highlighting the problems and needs, and providing information that can be used in developing action plans for improving performance" (Chiesa et al., 1996, p.105). Their audit has two dimensions: a process audit (see Figure 3.1) and a performance audit.

Figure 3.1: The Innovation Process (Chiesa et al., 1996, p.107)



Here again there is a shift away from measuring outcomes of product performance to an evaluation of process performance. Their process audit also examined the extent to which best practice is used, though what constitutes best practice in any given situation is not clear. When the audit tool was used in companies, the respondents themselves defined it on a rating scale of 0–100, where 100 was their *perception* of world class, and they rated their own performance on the scale to establish a process performance gap. Chiesa et al's (1996) examination of the innovation process and best practice, and the gaps that may exist between the two,

provide organisations with an action program for closing those gaps. In this respect it carries on the tradition of previous best practice audits (Booz et al., 1968, Booz et al., 1982, Griffin, 1997, Page, 1993) while providing a company-specific guide to process improvement. Caffyn's (1998) work on the important behaviours underlying the new product development processes provides an even deeper analysis of the managerial actions that are necessary for process improvement.

The second part of Chiesa et al's (1996) technical innovation audit suggests a range of measures for assessing the four core processes:

1. product innovation (or concept generation),
2. product development,
3. process innovation, and
4. technology acquisition;

and three enabling processes:

1. leadership,
2. resourcing, and
3. systems and tools.

Data collected for these processes can be used over time to compare current and past performance, for performance against established goals, or for comparison with competitors. This last category of performance evaluation is more problematic, given the difficulties associated with getting comparable data from the competition. Finally, the innovation audit suggests a group of performance measures for measuring the impact of innovation on the firm's competitive performance. The performance measures used are the traditional, aggregative metrics such as sales, market share, and profits, though these are broken down from the total product level to individual products.

The impact of an individual innovation on competitiveness is further broken down into its impact on sales and profitability, its impact on the firm's product portfolio, and its impact on the firm's capability to generate further innovations. Whilst all innovative firms seek to increase sales, profitability and competitiveness through the development of new products, it may be that for specific industries, the impact of

innovation on a firm's product portfolio, and its capacity to generate further innovations are counter-productive. For instance, capital-intensive industries, industries with high set-up costs, and those whose products have a long time horizon, such as aerospace and automobiles, need a greater time to recoup their initial investment, restricting them from bringing out a continuous stream of new models within a short time frame. Nevertheless, the complexity of such products would allow for substantial innovation from component manufacturers where the capital investment is much smaller, and where competition is greater. Conversely, certain industries may have high capital costs but low set-up costs, such as major hotel chains or software manufacturers. Whilst initial investments may be high, reconfiguring the service and product mix is relatively easy, so these areas may thrive on innovation and the ability to learn within the innovation process. The audit tool developed by Chiesa, et al., (1996) is valuable in that it provides a link between process performance and firm performance, and a prescriptive guide for practitioners seeking to improve the performance of their product innovation processes.

The ability to learn through innovation, and improve new product development performance, is seen by many as critical to developing successful new products (Bartezzaghi et al., 1997, Boer et al., 2001, Hughes and Chafin, 1996, Imai et al., 1985, Lynn et al., 1998). Measuring this learning ability presents an even greater challenge. Chiesa et al., (1996, p.116) suggest a range of proxy measures, including "sales, market shares, and profits of a series of innovations linked to one another (among which is the innovation considered)." Caffyn's (1998) adaptation of the CI Capability model to the NPD process to measure the maturity of behaviours deemed important to continuous improvement in new product development also shed some light on the measurement of learning within the NPD process. Two of the nine key behaviours relevant to continuous improvement in new product development were linked to learning. Behaviour 7 addressed how people learnt from their own and others' experience, both positive and negative, and Behaviour 8 dealt with how the learning of individuals and groups is captured and deployed. The more recent emphasis on the measurement of behaviours, and learning behaviours in particular, can be seen as a response to observations of earlier writers. Specifically, Caffyn's work can be seen as a response to Page's (1993, p.272) observation that whilst a

greater emphasis on product innovation had led to improvements in practice, "there had been no notable improvements in the overall performance of the new product development activity within the responding companies." Further, the research of Chiesa et al., (1996) represents an effort to address Brown and Eisenhartdt's (1995, p.373) observation that empirical work needed to be done to test the "fundamental theoretical links" between "process performance, effective product, market factors, and financial performance."

A model of learning within the new product development process that combined the work of Caffyn, Bartezzaghi, Chiesa and others, emerged from research conducted by European and Australian academics into product innovation, on behalf of the European Community (Boer et al., 2001). This joint Euro-Australian CIMA project (Continuous Improvement of global Innovation Management) gave rise to the CIMA model that was developed to describe the continuous product innovation process in terms of a set of inter-related variables, namely:

- organisational learning ***behaviours***,
- ***levers*** which are specific actions, tools or techniques available to management in developing and consolidating relevant behaviours, and
- **performances** which are specific measures relating to the outputs of the product innovation process as well as the improvements in the process over time.

Importantly, metrics were developed to measure all three variables within a contingency framework. The learning behaviours were measured in terms of their frequency of use, and the extent to which they were diffused throughout the organisation. The levers were measured in terms of their use to influence specific behaviours. The performance metrics examined in the survey represent the usual output measures, and were aggregated into groups as shown in Table 3.3.

The CIMA survey found that the measures generally chosen by firms are lag indicators and do not provide the information necessary to improve the product innovation process. According to the researchers, organisations could overcome this deficiency in their performance measurement systems by using the CIMA model.

The learning and improvement aspects can be evaluated by assessing whether or not those Behaviours that encourage learning and continuous improvement in the product innovation process are spread throughout the organisation. This spread is measured by observing the frequency and diffusion of the Behaviours identified in the model. As these Behaviours become more widespread and frequent, they become embedded as organisational capabilities that support learning and continuous improvement in the product innovation process. The CIMA methodology represents one of the most recent approaches by researchers to establish a model that will support new product development performance.

Table 3.3: Performance Measures for Innovation Considered in the Survey

1. Time to Market Measures	*4. Impact on Firm's Competitiveness*
♦ Concept to Launch Time	♦ Sales in Domestic Market
♦ Time for Concept Phase	♦ Sales in Regional Market
♦ Time for Design Phase	♦ Sales in Global Market
♦ Time for Initial Prod'n Phase	♦ Domestic Market Share
♦ Time for Launch Phase	♦ Regional Market Share
♦ Overrun	♦ Global Market Share
2. Product Performance	*5. Impact on Firm's Product Portfolio*
♦ Unit Cost	♦ Profits
♦ Production Cost	♦ Sales of Portfolio
♦ Development Cost	♦ Profits of Portfolio
♦ Technical Performance	
♦ Quality	
3. Design Performance	*6. Other Metrics*
♦ Manufacturing Cost	♦ Total R&D Expenditure
♦ Manufacturability	♦ Planned vs. Actual Project Spending
♦ Testability	♦ Return on Investment (ROI)
♦ Number of Product Redesigns	♦ No. of Patents and Licenses Generated
	♦ Score on Customer Satisfaction Audit

The CIMA model also provides a list of Levers or tools that practitioners can use to promote improvement efforts. Further it provides measures for the relevant behaviours in order to establish a baseline against which to assess improvement efforts. Finally the CIMA construct connects learning behaviours to new product development performance and provides a tool for managers to use to continuously improve that performance. The CIMA model is of value in measuring new product

development performance by identifying gaps in the diffusion and frequency of behaviours deemed important to NPD success. Further is provides insights into the types of tool and levers that management should implement to encourage improved performance.

3.6 Conclusion

This chapter reviews the development of performance measures for product innovation activities. The complexity and uniqueness of those activities meant that performance measurement was avoided as being too difficult, irrelevant, or worse, counter-productive in that measurement stifled creativity and risk-taking. Initially, organisations that did measure their new product performance concentrated on the product, its impact on sales, profitability and competitiveness.

When researchers began to focus on new product development processes, it was to gain an understanding of the process, rather than to measure the process. The success or otherwise of the process was judged by the success or failure of the new product, rather than the efficiency (or lack of efficiency) in the process that developed it. Gradually, in response to ongoing research, and a growing recognition of the importance of new products in gaining and maintaining competitive advantage, quality and improvement efforts were brought to bear on the process that spawned new products.

This necessarily meant that performance measures for the process, and not just the products, had to be developed. These performance measures for new product development emphasised reduced development time, efficiency in design, and meeting or exceeding new product project objectives. The expansion from product-based to process-based measures of new product performance led to a greater understanding of product innovation activities, and better practice, but improved performance outcomes did not necessarily follow (Chapman and O'Mara, 2001, Page, 1993). This may have been due to a more competitive external environment that required organisations to improve efficiency simply to maintain their market position. Only by improving at a faster rate than the opposition would a performance improvement register.

Current research is directed towards understanding and improving the behaviours that underpin new product development activities. Necessarily, performance measures must be developed to measure improvement in these behaviours. Caffyn's new product capability maturity model and the CIMA's frequency/diffusion matrix are examples of performance metrics for behaviours associated with incremental improvement and learning activities that are critical to new product development. As understanding of the new product development process has grown, and as the relationships between important variables that contribute to new product success have been identified, performance metrics have been developed to quantify those variables, and provide feedback to practitioners hoping to improve their new product performance.

Recent research (Chapman and O'Mara, 2001) into new product development in Australia suggests that most current measures of performance evaluate the product, not the process that produces it. Even less attention is paid to the underlying behaviours. This gap in NPD research is examined to some extent in SMEs when reviewing the data for research questions two and three.

The methodology used to collect data to examine the relationship between product, process, and behaviours in new product development, and the measures used to evaluate these components is reviewed in the following methodology chapter.

Chapter 4

Methodology

4.1 Introduction

The idea for this research arose out of earlier work in the linkages between strategic objectives and organisational performance measurement in small to medium sized Australian manufacturing firms (O'Mara, 1996). This research identified, amongst other things, that performance measures were unresponsive to strategic shifts. Subsequent research into the learning processes that take place within organisations as a result of innovative practices also identified the importance of having appropriate performance measurement systems in place. Finally, research into how firms evaluate their new product development performance identified several gaps in the literature that seemed worthy of investigation.

Research into new product development practices tended to concentrate primarily on large organisations. Early studies concentrated on a case study examination of successes and failures, in an effort to identify 'best practice'. Later studies tended to adopt a more holistic approach. As understanding of the complexities of innovation management grew, the literature began to examine the drivers of successful innovation management (Caffyn, 1998, Cooper, 1994, Corso et al., 2003). In the case of innovative new products, these included identification of product characteristics that satisfied consumer needs, early entry with new product offerings, an integrated approach to new product development, and careful management of the new product development process (Trott, 2005, Burgelman et al., 2004, Crawford and Di Benedetto, 2003).

Most of these studies involved large organisations, with internal capabilities that could convert a new product concept into a genuine business opportunity, which may lead to a successful new product launch. The number of firms that meet these criteria is becoming more and more limited. Even large organisations often pursue a

variety of collaborative paths in the development of new products. They include partnerships, joint ventures, collaborations, and licensing of technologies. Very few small firms have the resources necessary to bring a product concept to market, so their innovation activity typically involves a subset of the overall innovation process.

This research examines several research questions that a relevant to small to medium sized manufacturing firms in regard to their role in the innovation process, specifically as it relates to the development of new products. Many of the firms approached to participate in this research did not even consider themselves to be innovative, or to produce new products, even though virtually everything they produced for external customers was a new product for the firm. With small to medium sized firms, their role in the new product development process was often not understood. That being said, the question to be asked is whether the growing body of literature on the management of innovation and new product development was relevant to small to medium sized firms.

Based on prior research, several questions emerged as being worthy of further exploration. Earlier research carried out into the link between strategy and performance measurement (O'Mara, 1996) demanded that the link between new product development performance metrics and NPD strategy be examined. Further, the relationship between NPD strategy and business unit strategy also needed to be evaluated. Research into innovation management in large organisations indicated that firms who experienced success in this area had well developed and managed innovation processes. Small to medium sized firms however tend only to be involved in a very small part of the extended innovation process. For such firms the important issue is how well they manage new product development projects. The capacity of small to medium sized firms to learn from, and improve their new product development processes should be an outcome of successful management of NPD projects, so this too became a relevant element of the research.

4.2 Development of a Theoretical Framework

Research into new product development practices within large organisations usually involved a case study approach, where the characteristics and practices of successful firms were identified. Several larger studies have gone on to develop best practice benchmarks (Griffin, 1997, Page, 1993). Very little work has been done in this regard with small to medium sized firms. One reason for this may be that small to medium sized organisations rarely employ the full range of innovation activities that range from idea, to concept, to design, through production to marketing. For this reason the research focus was narrowed to a review of NPD practices in small to medium sized manufacturing firms, with the emphasis on new product development activities. These activities concentrate more on production and design, than conceptualisation of ideas and marketing of product. Typically in the small to medium sized manufacturing sector, these activities occurred outside the firms that contributed to this research. The approach taken with this research was to review the existing literature on NPD, to identify the critical success factors for large firms, and determine whether they were also relevant to small to medium sized firms. A review of innovation literature identified several areas of best practice in large firms which then became the central issues for research in this thesis. These, previously identified in the preceding literature review chapters were:

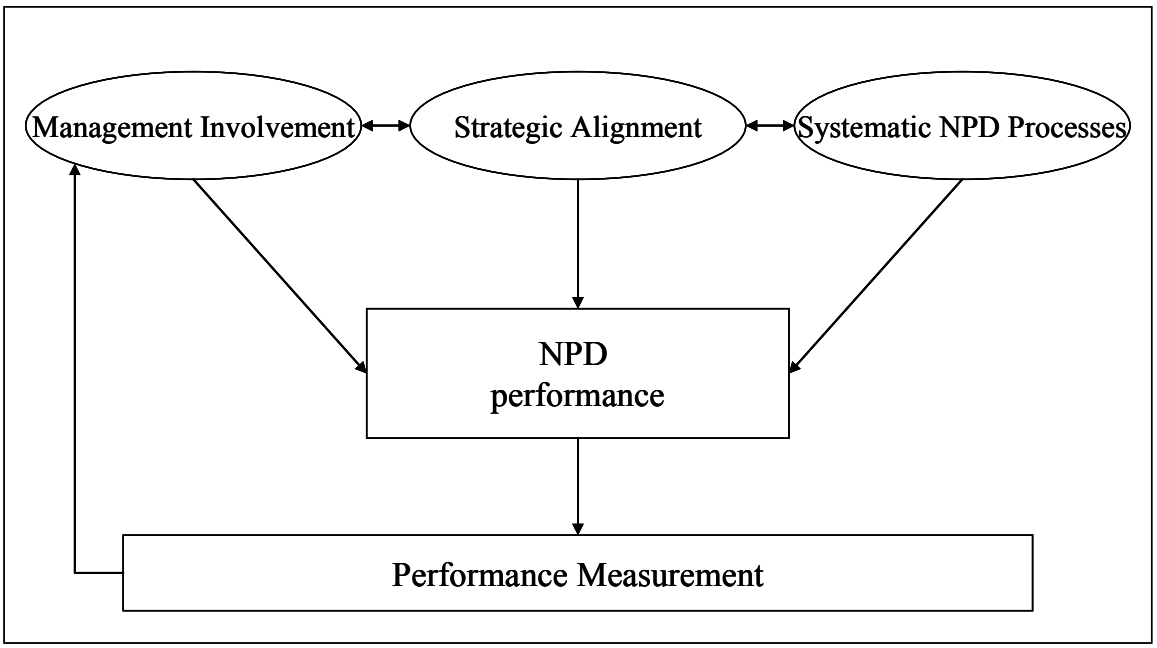
- The alignment of NPD strategy with the business unit's competitive strategy.
- The impact of management on improvements NPD performance through positive action programs.
- The degree of systematisation in NPD projects, and
- The influence of performance measurement on NPD performance and strategy.

Each of these areas is multi-dimensional. For instance, organisations can choose to pursue a wide range of competitive strategic options. The choices organisations are faced with in terms of improving new product development performance are extensive, as are the types of performance measure they might choose to employ. Finally, the procedures employed by businesses to manage their new product development projects can range from highly systematic to informal.

The survey instrument and interview pro-forma had to be developed to collect data on these four important drivers of NPD management in the small business environment. Research conducted in large organisations sought to identify best practice through identifying activities within firms that resulted in successful new product outcomes. Accordingly, the data collection tools used in this research also sought to determine whether similar activities were prevalent in small to medium sized firms that exhibited superior new product development performance.

The relationship between these four areas and their impact as drivers of new product development performance is shown in Figure 4.1.

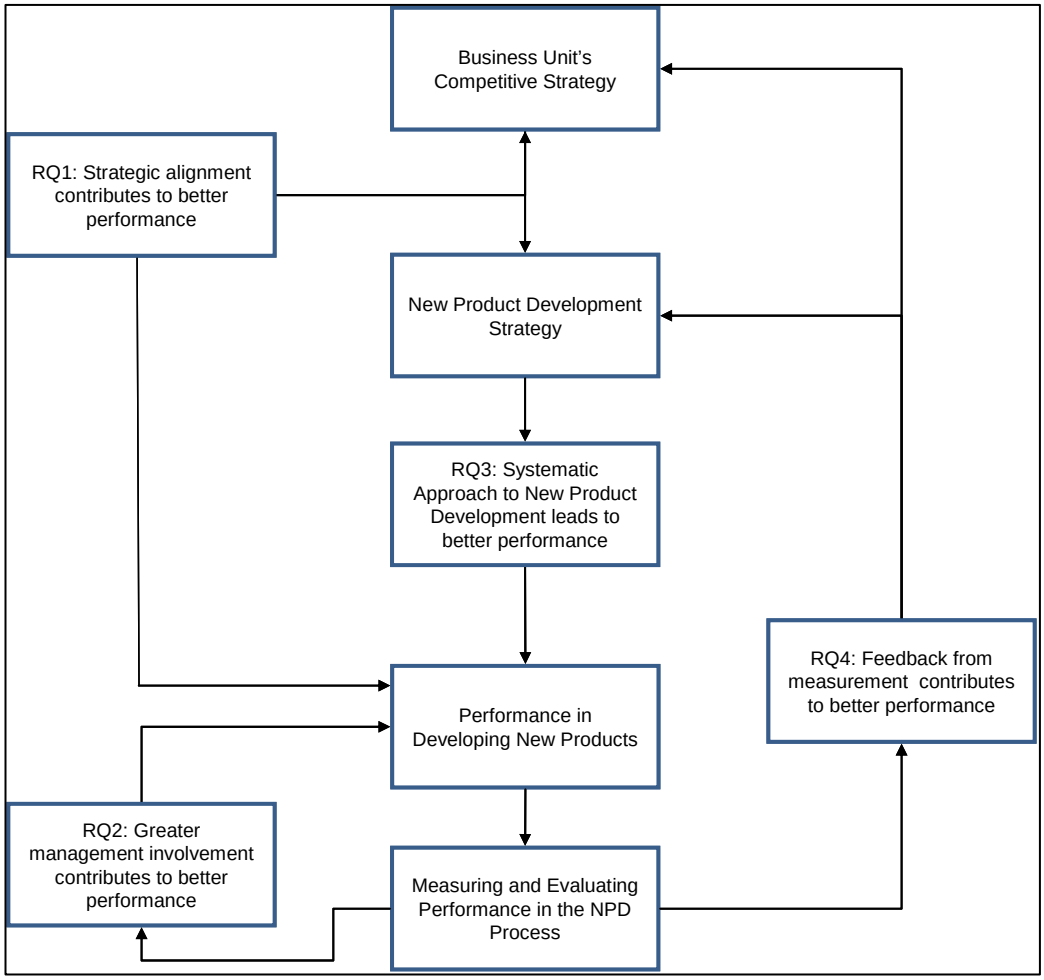
Figure 4.1: Drivers of New Product Development Performance



As was mentioned in the literature review chapter on performance measurement, what gets measured gets managed (Flamholtz, 1996). Performance measurement should also inform strategic choices (Kaplan and Norton, 1996b). Further, Neely et al. (1997) argue that the choice of performance metrics should be part of a systematic approach to managing business processes. In the preliminary model shown in Figure 4.1, performance measurement is shown as impacting on new product development performance through its influence on the actions of managers. These relationships were refined into a theoretical framework as shown in

Figure 4.2. This figure also displays how the research questions that are central to this thesis relate to a firm's new product development performance. Having developed this theoretical framework, the next step was to design a set of tools for the collection of data to examine these linkages.

Figure 4.2: Theoretical Framework



The above framework has been developed from the literature on NPD and performance measurement. The need to closely align NPD strategy and business unit strategy (RQ1) is strongly grounded in the literature (Christensen, 1999, Griffin and Page, 1996, Trott, 2005). The link between NPD strategy and the process used to bring new products to market is also supported by prior research. The execution of a strategy is critical to successful outcomes (Cooper, 1994). Formal processes (RQ3) were identified as a contributor to successful NPD outcomes (Cooper and Kleinschmidt, 1986). The use of performance measures to inform strategy (RQ4) is

supported by research conducted by Kaplan and Norton (1996b). Active managerial involvement (RQ2) in developing organisational capabilities in the area of innovation is also supported by research (Boer et al., 2001, Caffyn, 1998, Corso and Pavesi, 2000). Management's ability to take appropriate corrective action necessarily involves the use of appropriate data from measurement and evaluation of NPD projects (Alegre et al., 2006, Gieskes, 2001, Griffin, 1993).

4.3 Development of the Data Collection Instruments

The research undertaken in this thesis was exploratory, in the sense that it sought to determine whether observations of new product development performance in large organisations also existed in small to medium sized manufacturing firms. From a research design perspective, this study has elements of both the positivist and interpretive (Neuman, 2006). Neuman (2006, p.66) describes the positivist approach as "*an organised method for combining deductive logic with precise empirical observations of individual behaviour in order to discover and confirm a set of probabilistic causal laws that can be used to predict general patterns of human activity*". The positivist approach is embodied in the quantitative component of the research and predominates in this study. An interpretive approach involves "*the systematic analysis of socially meaningful action through direct detailed observation of people in natural settings in order to arrive at understandings and interpretations of how people create and maintain their social worlds*" (Neuman, 2006, p.71). This approach is adopted in the analysis of interview data.

Given the exploratory nature of the research, the quantitative data were supported by the more in-depth qualitative interviews. McCutcheon and Meredith (1993, p.239) had noted a "gap between what academics were assuming, and the real conditions" that existed within firms. Case study research is perceived as the principal means of obtaining better information about the realities of operations systems. An example of a two stage study involving quantitative data collection followed by case studies can be found in Dr Bhimani's (1993 and 1994) review of performance measurement practices in the United Kingdom. The two stage study was used "to provide a

relevant perspective for the findings of the basic questionnaire survey" (Bhimani, 1994, p.34). Two case studies were undertaken for that research.

Initially, a broad-based quantitative data collection instrument was developed, in an effort to capture some of the diversity and complexity that is inherent in the small business environment. This questionnaire was extensive in its coverage, and necessitated the involvement of the researcher in its administration. Pilot testing of the survey resulted in explanations and definitions of the various terms and concepts being included in the questionnaire. Around the same time that this questionnaire was being developed, it came to the attention of the researcher that a related project was being carried out by colleagues at Aalborg University in Denmark, in collaboration with Syddansk University, and the Technical University of Denmark. Their research concentrated on benchmarking operations processes and supply chain management processes in Denmark. The new product development questionnaire developed for this research was also incorporated into this broad-based survey. The benefit from doing this was to collect data on new product development practices from a wider range of small to medium sized firms.

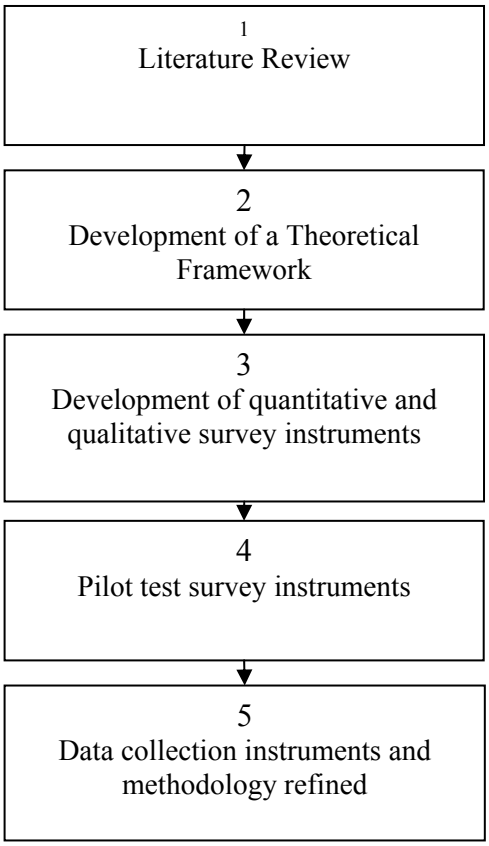
This collaboration required the development of a multi-part survey instrument. The four components that were eventually used included a generic business unit module (Appendix 1), to gather demographic data on each respondent organisation, and three other modules for data collection in the areas of operations, supply chain management, and new product development practices. The generic business unit module shown in Appendix 1 is a modified version of the survey form developed in Denmark and subsequently administered to Australian companies. Whilst all participating firms involved in the research completed the generic module, these firms could choose to complete any, or all of the three specific modules that were of interest to them. The data used in this thesis come from those firms that completed the module on their new product development practices (Appendix 2), and met the small to medium size criteria.

With complex processes like new product development, it would be rare for one person to have a comprehensive grasp of the all activities involved, even in smaller business units. As a consequence and for use in this thesis, quantitative data would

be complemented with qualitative data from a series of three in-depth interviews in three of the firms that contributed to the quantitative component of the survey. Given that the NPD component of the research was driven from Australia, these would be Australian firms and would be selected from the higher and lower end of the spectrum of surveyed firms, in terms of number of employees, with the third firm coming from the middle of the size range. The participants in the interviews were employees who had not been exposed to the quantitative surveys. Accordingly, a structured interview pro-forma (Appendix 3) was developed concurrently with the quantitative survey, to gather qualitative data from different managers within the respondent firms. This structured questionnaire was to be administered to personnel within the selected firms who were responsible for the important functions of design, operations and marketing.

In some of the smaller business units, these functional units would not be present. Design was often absent altogether, with firms relying on customers to supply manufacturing specifications and drawings. Operations functions predominated in the small to medium sized manufacturing firms. Marketing quite often existed solely in the form of a close customer relationship between the firm's principal and its customers, and was confused with sales. At the larger end of the range of participating firms, functional areas typically had separate individuals who were responsible for these activities. In smaller firms, individuals often had responsibility for multiple functions. The firms chosen to participate in the qualitative component had individuals who were responsible for the discrete functional areas. This more comprehensive series of interviews was intended to provide a clearer picture of communication within the firms in the areas of strategy dissemination and alignment, managerial involvement, the consistency of management's approach to managing new product development activities, the extent to which performance was measured, and the degree of teamwork that existed in new product development activities.. The stages that led to the development of the survey instrument and interview pro-forma are shown in Figure 4.3.

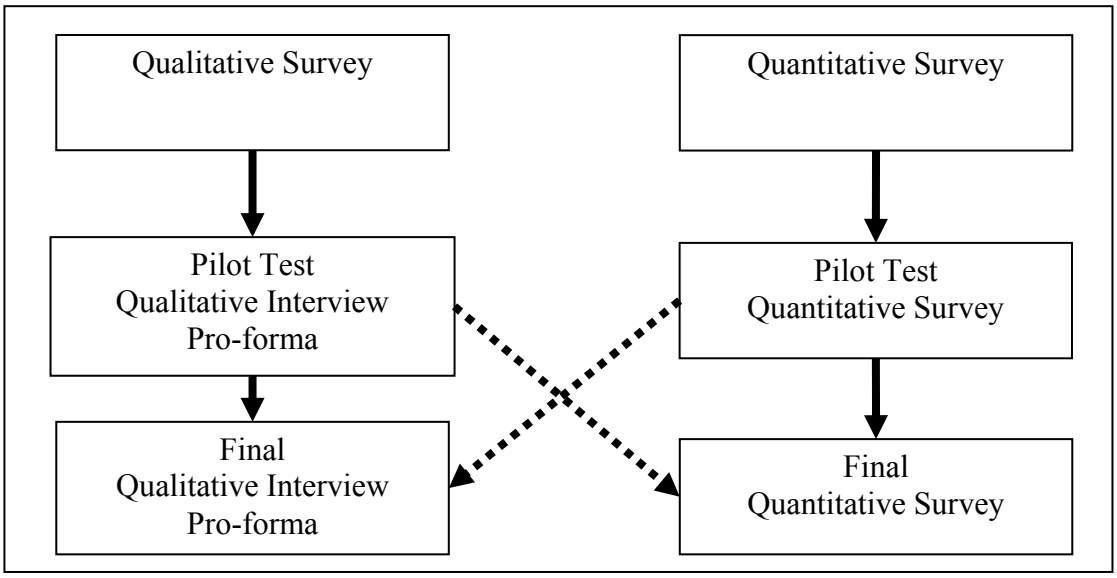
Figure 4.3: Development of the Data Collection Tools



The third stage resulted in preliminary versions of both the qualitative interview pro-forma and quantitative survey instruments. In stage four these data collection tools underwent pilot testing in two Australia firms that had been involved in earlier research into performance measurement. The questions that were developed following the literature review and subsequently incorporated in the quantitative survey remained virtually unchanged. As previously stated however, definitions and descriptions of the various concepts were included to assist respondents in answering the questions. Feedback from both the qualitative and quantitative instrument pilot testing informed the final versions of each. The qualitative survey became more structured, with questions grouped around the four research questions to be examined in the thesis. The questions were designed to examine these issues in greater depth than was possible through the quantitative survey.

A more comprehensive way of displaying stages three to five is shown in Figure 4.4.

Figure 4.4: Evolution of the Survey Instrument and Interview Pro-forma



The final data collection instruments are displayed in appendices.

Appendix 1 - the business unit quantitative survey instrument

Appendix 2 - the new product development unit quantitative survey instrument

Appendix 3 - the qualitative interview pro-forma

The quantitative survey questionnaire was quite complex. Many questions were straightforward, for instance those that collected demographic data, or sought to determine the presence or absence of specific activities or behaviours. Those central to the research questions that are examined in this thesis were somewhat complex, so an explanation of how the measurements relevant to them were developed is appropriate.

The NPD quantitative survey contained four critical questions, namely 2.1, 2.3, 2.5, 2.7, and 2.10. Question 2.5 sought information on changes in twenty-five NPD performance criteria over the previous three years against internal measures and against competitors' performance. Testing of this questionnaire showed that most organisations did not maintain definitive data, but relied more on subjective opinions of managers on how well their business unit was performing. For this reason, five point Likert scales were used to measure responses to the question.

Operational definitions for each of the twenty-five performance dimensions were provided in the survey instrument. As well rules of measurement were provided to guide assignment of a value to the various numbers of the five point scale. Ordinal scales were used, again because of the unavailability of concise quantitative data from respondents. Question 2.7 followed the same method in collecting data across up to 17 possible NPD action programs. Data from these two questions was used to explore research questions four and two respectively.

Question 2.1 collected data on NPD strategy and mirrored question 1.4 from the Business Unit quantitative survey. In conjunction, responses to these questions were used to evaluate research question one that dealt with alignment of strategy between the business unit and the NPD function. In both cases identical three point scales were used to identify shifts in the importance of a range of strategic options. Again the choice of options was made based on trial responses to the survey questions, in order to avoid nil responses on this important question.

Data used to answer research question four was gathered using question 2.3 and 2.10. Both used four point Likert scales to gather data on the innovativeness of the NPD function (2.3) and the way their NPD projects were managed (2.10). In both instances operational definitions and rules of measurement were provided in the questions to enhance the reliability of responses. Four point scales were used in order to obtain responses that could separate companies according to the degree of innovativeness, or process formality, as was done in section 5.4 of this document.

4.4 Data Collection

The two firms involved in the pilot survey provided valuable input and feedback both on the survey instrument and interview pro-forma and the method of delivery. Despite the clarifications made during testing, it became apparent that the surveys would need to be administered by a qualified researcher. The quantitative components were designed for independent completion by respondents. However, the length of these questionnaires resulted in poor initial responses, and necessitated a face-to-face data collection approach. As a result, all data were collected using a researcher from either Aalborg University for firms located in Denmark, or by the

writer in the case of Australian firms. The qualitative survey was only administered to three selected Australian firms. The firms that provided data were selected from the pool of firms with appropriate SIC classifications under Division D – Manufacturing, and located in the greater Sydney region. 142 companies were selected from the database of over 1,200 firms maintained by the Innovation Technology Network at the University of Western Sydney. Selected firms were emailed an invitation to participate in the research. The questionnaires were quite lengthy and only thirteen firms offered to participate in the research

The first part of the survey gathered data on the small business unit, and was designed to be completed by someone in a senior managerial position. The second part was designed to gather data on new product development practices, and was intended to be completed by a respondent with managerial responsibility in design, operations or marketing. As is often the case with SMEs, the respondent sometimes had managerial responsibility in more than one of these areas. The NPD survey module was incorporated in an international research project, which also looked at operational and supply chain management practices. Those components of the research are not part of this thesis. In all, fifty-nine firms contributed data for the quantitative component of the research. The responses to questions that were relevant to NPD practices numbered about 40. Valid responses varied for each individual research question, and are detailed below.

The outcomes presented in this report are derived from the analysis of respondent firms located in New South Wales, Australia and Denmark. Not all questions were answered by all respondents, so some issues use responses from a smaller sample. The firms involved in this project were all product manufacturers, whose goods ranged from aircraft structures and components to swimming pools. The Australia Bureau of Statistics categorises a small business as one having less than 20 employees. A medium-sized business is one with employment of 20 to than 200 persons.(Australia Bureau of Statistics, 2002) Some of the business units were divisions of larger organisations, but the business units themselves met the size criteria of less than 200 employees. The Australian firms were selected from a database of firms maintained by the Office of Regional Development, at the University of Western Sydney. Danish firms were selected from Industry databases

using the same SIC criteria. Danish firms are required by law to contribute data for research. Forty-six firms completed the survey.

Roscoe (1975) maintains that samples sizes larger than thirty and less than five hundred are appropriate for most research. The collection of quantitative data was intended to identify differences in practice between SMEs and large organisations, and possible reasons for these differences. Since the research was exploratory in nature, a larger sample size was not sought. As well, the research was to be conducted in two parts, with the quantitative survey being complemented by in-depth qualitative interviews for a more detailed analysis of relevant issues.

The quantitative data for this study were collected from participating firms during face-to-face meetings between the researcher and a senior manager in the responding firm. Senior managers were interviewed with the expectation that they would have a sound understanding of organisational and departmental activities at they impacted on NPD performance. These interviews lasted about ninety minutes and involved collecting responses to questions about the business unit, and its NPD practices (Appendices 1 and 2). The length and complexity of the survey questionnaire required the involvement of the researcher, and prohibited a more widespread mail-out of the questionnaire. The firms that did participate were those that responded positively to an email request to contribute to the research. This email was sent out to New South Wales based small to medium sized manufacturing firms that were listed on the mentioned previously database. Danish firms that completed the NPD module of the broad-ranging survey were selected from the national industry database based on SIC classifications.

With the structure of the qualitative questionnaire decided, the next step was to select the subject firms for the qualitative interviews. Within the range of manufacturing SMEs, based on employee numbers, three were chosen. The first firm, company A was from the lower end of the range, having 50 employees. The second firm, Company B, had 110 employees, and Company C had 190 employees. Each of these firms had responded to the quantitative survey, and had expressed an interest to participate in the case study research.

Company visits involved a brief discussion with a senior manager, and collection of artefacts containing company data, followed by a site tour. Finally interviews were conducted individually with the three functional managers in each company who volunteered to participate. Interviews lasted up to sixty minutes. All interviewees were asked the same questions. The interviews were recorded on tape and later transcribed. After transcription, the respondents reviewed their answers, and where appropriate, provided clarifications and amendments. A transcript of one of the interviews is included as appendix 5. The size of the transcripts made it inappropriate to include full transcripts from all respondents.

4.5 Data Analysis

Data were collected firstly to determine whether NPD practices in SMEs differed from those that were seen as best practice in large organisations. Secondly, the data were to be used to investigate whether there were differences in NPD practices within SMEs in the approaches taken by better performing business units. Data were collected in such a way as to facilitate data reduction for factor analysis (Punch, 1998). This was to allow for ease of comparison between those categorized as better performers against those that performed less well, whilst still providing respondents the opportunity for individualised reports.

The data analysis begins with a descriptive analysis followed by a more detailed analysis of specific data, before concluding with a determination of the issue under examination. For the quantitative data, the Microsoft Excel program was used for data analysis. Where appropriate, a chi-squared test was used to test for differences between proportions. Where this was not appropriate, descriptive statistics were used (Levine et al., 1998).

The approach taken to analysing the qualitative data was to follow the theoretical propositions outlined in Figure 4.2. This methodology is explained by Yin (1994, p.103). The research questions sought to examine linkages in the theoretical framework. In the qualitative survey questionnaire, questions were grouped around the four research questions underpinning this study (see Chapter 1) in order to gather a rich amount of data relevant to each. The intent was to perform a thematic

analysis (Miles and Huberman, 1984) of the four research questions to identify commonalities or differences in SME practices against those reported for large organisations.

Analysis of the quantitative was designed to provide an understanding of the relevance of the four research questions for small to medium sized manufacturing firms. Research question one examined the relationship between the business unit's competitive strategy, its new product development strategy, and its new product performance. Research question two examined the level of management involvement in improving NPD performance in SMEs. Research question three examined whether a more systematic approach to management of NPD projects in SMEs would lead to better outcomes in terms of the degree of innovativeness and an improvement in NPD process performance. Finally, research question four examined the relationship between performance measurement and outcomes, and strategy, in the context of new product development and innovation practices in small to medium-sized manufacturing firms.

In addition to reviewing the quantitative data to evaluate how SMEs approached new product development from these four perspectives, the sample firms were split into two groups, based on their responses to questions regarding their NPD performance. Those reporting improved performance were grouped together. The second group included firms who reported no change, or a drop in performance. The questionnaire sought a subjective assessment of NPD performance from respondents across a range of dimensions (Appendix 6). The organisations that participated in this research were asked to describe their new product development performance across twenty-six different performance dimensions. Two of these, time-to-market, and quality conformance, were analysed for the purpose of evaluating whether or not actual performance outcomes influence the choice of future action plans. These two were chosen from those listed question 2.5 of Appendix 2, based on the importance placed on them in the literature as critical indicators of the likely success of new products (Allocca and Kessler, 2006, Brown and Eisenhardt, 1995, Cooper, 1979).

Establishing direct linkages between business units, NPD function and performance outcomes would only be possible on a case by case basis, and given the diversity present in organisations, these linkages would be contingent on company demographics and conditions prevailing at the time. The quantitative portion of the research involved the completion of lengthy questionnaires, usually by a single respondent, and that person's understanding of the relationship between the strategic choices of various sections of the firm would be biased towards that individual's perceptions. In the qualitative interviews, the intention was to interview personnel more closely tied to functional roles, specifically, operations, design, and marketing. Input from different managers would provide a clearer picture on the strength of the relationship between competitive strategy, new product development strategy, and new product performance.

The second research question examined the level of management involvement in improving NPD performance in SMEs. Presumably a higher degree of involvement would lead to better capability development and outcomes over time, across a range of NPD performance measures.

In the quantitative survey, managers were asked to comment a range of action programs that they had employed in order to improve their business performance. Data were collected on the degree of effort put into these action programs, and the perceived benefits that were derived from them. Effectiveness of individual programs could not be evaluated, but overall business and NPD performance could be assessed using a broad range of performance dimensions (Appendix 2, q. 2.5).

In the qualitative interviews, individual action programs were not examined. The tendency would be to select and comment on spectacular successes or failures. Rather, respondents were asked to comment on their most effective types of action programs (Appendix 2, q. 2.7).

Individual action programs were evaluated using different performance metrics, depending on the underlying objectives of the program. The data were also analysed to determine whether the organisation has a preference (or bias) in the use of performance metrics. With this is mind, in the in-depth interviews the

respondents were asked whether their organisations evaluated the performance of action programs. Several issues emerged when examining the various action programs employed by organisations, and these are covered in detail in chapter six where the research findings are presented.

Research question three looked at whether a more systematic approach to management of NPD projects in SMEs would lead to better outcomes in terms of the degree of innovativeness and an improvement in NPD process performance. The overwhelming position taken by management literature is that formal processes provide the basis for improvement and that a systematic approach produces more consistent outcomes (Griffin and Page, 1993, Kerssens-van Drongelen, 1999, Schilling and Hill, 1998). In large organisations, systematic product development processes are employed more often in firms that are acknowledged as best practice firms (Griffin and Page, 1993). No significant research has been conducted into the extent or impact of systematic or formal NPD processes in small to medium sized firms.

From the quantitative survey data, innovativeness did not seem to be influenced by the way in which NPD projects were managed. As well, NPD project outcomes in SMEs did not appear to be influenced by the approach taken to managing such projects, whether it is systematic or informal.

Finally, the fourth research question examined the relationship between performance measurement and outcomes, and strategy, in the context of the new product development practices in small to medium-sized manufacturing firms. Performance measurement should inform strategy (Kaplan and Norton, 1996b) and where performance measurement demonstrates an unsatisfactory outcome against some stated goal, an effective strategic management system would identify such areas to be targeted for attention in future periods.

In the quantitative survey, performance outcomes across a wide range of metrics were examined. The reported results were then compared to the various future action programs that the respondents intended to pursue, in order to evaluate whether past performance informed future strategic choices. Issues explored in the

in-depth qualitative interviews revolved around the effectiveness and use of performance measurement in improving new product development practices, and in guiding the strategic direction of the organisation

The questionnaires, as administered were quite comprehensive, with one outcome being the ability to identify firm-specific issues about their new product development practices. This however, was not one of the thesis objectives, where a more general analysis of the four research questions was sought. As a consequence, many of the questions, and much of the data obtained from them, were not included in the data analysis. The relevant questions from the quantitative survey and qualitative interview pro-forma, that provided data pertaining to the four research questions, are shown in Table 4.1. This table lists the theoretical construct, identified in large organisations, which informed the research question to be investigated in the small to medium sized business environment. The key question used to evaluate each research question was number 2.5 from the NPD quantitative data survey. This question collected data on new product development performance across a range of indicators. The objective was to determine whether the drivers of better new product development performance in large organisations would also be applicable in the small business environment.

Table 4.1: Data Analysis Matrix

Theory	Research Question	Quantitative Data	Qualitative Data
Theory suggests that a close alignment between a business unit's strategy, and its NPD strategy should lead to improved business unit performance across a range of dimensions.	RQ 1: Is the business unit's competitive strategy supported by its NPD strategy?	G1.4 N2.1 G1.6 N2.2 N2.5	4-7
Theory suggests that organisations that actively manage their NPD process will benefit from improved perf. across a range of dimensions.	RQ 2: What is the level of management involvement in improving NPD processes and performance?	N2.5 N2.7 N2.9	11-17, 27
Theory suggests that a more systematic approach to management of NPD projects leads to better outcomes.	RQ 3: How should SMEs manage their NPD projects?	N2.5 N2.10	22-27
Theory suggests that performance measurement should provide an input into the strategic direction of a business unit.	RQ 4: Do SMEs measure NPD performance, and does such measurement influence strategy?	G1.4 N2.1 N2.4 N2.5	8-10, 18-21, 27

Legend: *G# refers to the number of the question in the general section of the quantitative survey; and N# refers to the number of the question in the new product development section of the quantitative survey.*

4.6 Conclusion

In this chapter, the choice of a two stage study, using a quantitative survey instrument, followed by complemented in-depth qualitative interviews was justified by reference to relevant authorities. Detailed descriptions of the procedures used in the collection of both quantitative and qualitative data were provided. Appendices 1 and 2 contain the quantitative survey questionnaire. Appendix 3 contains the qualitative interview pro-forma. The data which are relevant to the four research questions has been summarised in Table 4.1. The data collected from the quantitative research and that were used in this thesis are presented in Chapter 5, whilst the qualitative data collected will be reviewed in Chapter 6. A discussion of the findings, and conclusions based on the data analysis are presented in the final chapter.

Chapter 5

Quantitative Data Analysis

5.1 Introduction

This chapter is the first of two that presents and analyses the data gathered during the course of the research. In this chapter, the responses to the quantitative survey questionnaire are reviewed. In the following chapter, Chapter 6, the detailed qualitative responses of various managers within three selected firms are examined. In both the chapters dealing with data analysis, the chapter structure is developed around the four research questions under investigation. As was discussed in the Methodology Chapter 4, data was received from fifty-six business units, but not all fifty-six provided responses to all the questions contained in the quantitative survey, therefore, the number of responses shown in the various tables in this chapter will vary.

5.2 Research Question One – Strategic Alignment

In chapter two where the new product development literature review was presented, several critical success factors were identified as being contributors to positive NPD outcomes. The first of these was that new product development strategies should be aligned with and support the business units competitive strategy (Trott, 2005, Christensen, 1999). Where such an alignment exists, then presumably better outcomes will result from new product introductions. What constitutes a better outcome was left to the subjective responses of the respondent organisations personnel due to the difficulties in directly connecting business outcomes to specific NPD projects (Werner and Souder, 1997, Brown and Svenson, 1988, Griffin, 1993). This relationship is represented graphically in Figure 5.1.

Figure 5.1: Linking Outcomes to Strategy

Strong linkages exist where there is a close alignment between the business unit's strategy and its new product development strategy. Better performance is a relative concept, and in the context of this research relies more on the subjective assessment of the respondents rather than objective measures, as will be discussed in the data analysis and evaluation that follows. Evaluating the performance of the business units incorporates the respondent's assessment, as distinct from objective measurement, across a wide range of new product development performance metrics that are frequently found in the literature on NPD performance. The performance metrics or dimensions that the organisations were requested to report on are listed in Appendix M.

Respondents were also asked about the performance of their competitors. In a competitive world, such comparative measures are more likely to give a better indication of performance improvement (Voss et al., 1992, Young, 1993) In this regard, the responses indicate that most SME's do not assess the performance of their competitors (20 of 34 or 58.8%). This would be seen as a shortcoming in most organisations, and especially larger organisations, but perhaps there are mitigating circumstances for SMEs. Firstly, SMEs tend to operate in niche markets, providing a small range of specialised products, or are geographically isolated. Further, manufacturing SMEs generally sell the majority of their output to larger organisations that have effective supplier performance examination programs. Thus whilst most of the respondents stated that they do not evaluate the performance of their competitors, measures such as the market share of new products could be a proxy measure of performance against competitors. In this regard, the majority (66.67%) of respondent organisations reported an improved performance (Table 5.1).

Table 5.1: Market Share of New Products

Performance Change	Quantity
Improved > 20%	10
Improved ≤20%	10
Unchanged	7
Declined	3

Much of the quantitative data presented in this section can be used in such a subjective manner, and whilst the presentation and interpretation of the findings from the survey research is useful, it is in the three detailed case studies that the linkages can be more closely examined.

The rest of this section is devoted to an examination of the relevant survey data as it relates to the first research question.

5.2.1 The Business Unit's Competitive Strategy

Respondents were asked to prioritise their top three competitive strategies from a list of eight specified strategies. The respondents also had the option of nominating a competitive strategy not included amongst those listed. The eight specified strategies were: profit, market share, growth, employment, survival, innovation, reputation, green production, and other. These strategic choices stem in part from the work of Miles and Snow (1978). They propose four business strategy typologies: prospectors, analysers, defenders, and reactors. Firms categorised into these typologies will pursue different strategic options. Prospectors for instance, tend to emphasise growth, market share and innovation, even at the expense of short-term profitability. Analysers are seen as being imitative, and capable of responding to competitive innovations. They concentrate on their profitability and market share. Defenders look to expand their existing product range rather than pursuing discontinuous innovations. Reactors adopt an inconsistent strategic position and respond to environmental influences. Their concern is with financial stability and survival. The second source for these business unit competitive strategies was the Oslo Manual (OECD-EUROSTAT, 1997). The Oslo Manual is "one of the standard methodologies used by governments and policy makers to

study the processes and practices of innovation in private firms and commercial establishments" (Hughes, 1999). The Oslo Manual recommends that outputs of innovation activity which include revenues, profits, productivity, and employment need to be evaluated. As well, the impact of innovation should be assessed through qualitative measures (such as reputation), and environmental impacts. In presenting the data, the ranked choices of business unit strategies were given weightings of 3, 2, and 1, for their first, second, and third choices respectively. The results are shown in Table 5.2.

Table 5.2: Business Unit Competitive Strategies

Strategy	Top-three	First Priority	Second	Third	Total
Profitability	35	45	20	10	75
Innovation	24	15	18	10	43
Growth	20	24	14	5	43
Reputation	15	12	8	7	27
Market Share	14	3	10	6	19
Survival	4	12	0	0	12
Employment	4	3	6	0	9
Green Production	1	0	2	1	3
Other	1	3	0	0	3

Of the 56 organisations surveyed, 39 chose to supply information on their business unit's competitive strategy. The great majority focused on profitability with 89.7% (35 of 39) listing it in their top three. Second in terms of strategic priorities for the SMEs that were surveyed was innovation, with 61.5% of respondents listing it as one of their top three priorities. This was closely followed by growth strategies at 57.1%. These strategic options ranked equal second when weighted.

The literature is quite clear that innovation is a proven path to long-term profitability, sustainability and growth, so it is not surprising to see these three strategic priorities so closely linked. The important issue for this research is whether these business unit competitive priorities line up with the strategies that are in play with regard to developing new products. This point is examined in the next section.

5.2.2 New Product Development Competitive Priorities

A different range of choices was offered to respondents for new product development strategies, and the results are shown in Table 5.3. These choices were weighted in the same manner as the business unit strategic choices, in order to present a more realistic total importance ranking. The reason different options were offered was because NPD departments action competitive priorities differently to the business unit. The emphasis is on the product and its impact on the organisation, whereas the business unit's strategy has a broader scope. The literature on new product development emphasises a customer focus in terms of product marketability, and time-to-market as critical in terms of successful product introductions. Other important criteria for developing new products comprise the rest of the list of options.

Table 5.3: New Product Development Competitive Strategies

Strategy	Top-three	First Priority	Second	Third	Total
Product functionality	27	33	14	9	56
Product design/innovation	19	24	14	4	42
Product price	19	24	8	7	39
Product customisation	11	9	8	4	21
Time to market	12	6	8	6	20
Conformance quality	11	3	10	5	18
Company reputation	7	6	8	1	15
Product range	6	6	6	1	13
Environmentally sound products	2	3	0	1	4
Other					

Several issues emerge from the data on new product development strategies, not least of which is how to make a comparison between business unit strategy and NPD strategy, given the different competitive priorities between them. This will be addressed at the end of this section.

From the data in Table 5.3, one can observe that the choice of competitive strategies employed in developing new products is more evenly spread than is that of business unit strategies. For business units, the overriding emphasis is on profit, with 35 of 39 respondents placing it a one of their top three strategic objectives. The strategic

focus for NPD competitive strategies is more diverse with product functionality topping the list at 27 of 30 responses. Profitability was the top-ranked business unit competitive strategy, but was not offered as an option under strategic criteria in new product development. Whilst undoubtedly being important, the lead-time in developing new products makes profitability determinations problematic in terms of deciding whether or not to invest in a new product. New product profitability is very much an ex-post assessment. In chapter three the literature review presented evidence of the link between innovation and long term profitability, and at the same time, the difficulties in attributing profit to specific new products. Nevertheless, many of the criteria listed in Table 5.3 are considered important for the likely success, and hence profitability, of a new product. Foremost amongst these would be product functionality, which in this research is defined as "the extent to which the product meets the customer's functional specifications and/or expectations." The last two categories in Table 5.3, 'company reputation' and 'environmentally sound products' do have direct comparisons with 'reputation' and 'green production' shown in Table 5.2. For both the business unit and the NPD unit, environmental considerations are very low, and when it comes to company reputation, this seems a far less relevant issue from a NPD perspective than it does from a business unit perspective. In terms of NPD strategy, company reputation rated in the top three for only 18.4% of respondents. At the business unit level, company reputation rated in the top three for 38.5% of respondents. It may well be that from an NPD perspective; an emphasis on product functionality will ensure that the company's reputation is preserved.

Business unit strategy is expressed in different terms than NPD strategy making a determination on the extent to which business unit and NPD strategies align somewhat problematic. What might further complicate the issue is the fact that several NPD competitive priorities can and do support the broader business unit strategies (Table 5.4). For these reasons, the decision was made to evaluate the emphasis placed on the supporting NPD strategy of the respondent SMEs by matching them to their first three business unit competitive strategies as shown in Table 5.2. We can reasonably state that the principal business unit competitive priorities of SMEs are profitability, followed by innovation and growth. Indeed, innovation and growth are strong drivers of profitability. But which NPD strategies

support these business unit strategies? Table 5.4 shows a matrix of NPD strategies that support the top three business unit strategies. The data for this table was extracted from the quantitative survey responses. For example, 35 companies listed 'Profitability' in their top-three business unit competitive strategies in Table 5.2. Of those 35, 19 listed product functionality in their top-three NPD competitive strategies. These responses were weighted on a 3-2-1 basis according to whether the NPD strategy was ranked 1, 2, or 3, respectively. These weighted scores were then divided by the number of responses to derive an average. This average can be viewed as an indication of the emphasis placed on a specific NPD strategic priority compared to the business unit competitive strategies for the companies sampled in this survey. A high average value may be indicative of an NPD strategy that is significant in terms of its use to support a business unit strategy. In this sample however, high average values are linked to relatively low response rates for specific NPD strategies. This is to be expected given that a smaller denominator is likely to produce a higher average. If we observe those NPD strategies where the observations are greater than ten then a picture begins to emerge of which NPD strategies are used more often to support the business unit strategy in SMEs. For instance, product innovativeness (2.19) and product functionality (2.0) appear to be linked with a business unit strategy that emphasises profitability. Product innovativeness also seems to provide support for an innovation strategy (2.0) and a growth strategy (2.11). This is consistent with innovation research in large organisations that identifies the degree of newness (innovativeness) of a product as being a significant contributor the likely success of an innovation. These NPD strategies are linked to business unit strategies in the literature (Burgelman et al., 2004, Cooper, 1988, Crawford and Di Benedetto, 2003, Ulrich and Eppinger, 2000). Depending upon the performance of the NPD unit, the impact can be either positive or negative. For instance, poor time-to-market performance can have a negative impact on profitability, and the ability to continue to innovate, and thus growth. A faster time-to-market presents opportunities that early entrants to market enjoy such as low competition, high margins, and thus growth and profitability, and the capability to continue to invest in new products.

Table 5.4: NPD Strategies that Support Business Unit Strategies

NPD Strategy	Business Unit Strategy								
	Profitability			**Innovation**			**Growth**		
	No.	**Weight**	**Avg**	**No.**	**Weight**	**Avg**	**No.**	**Weight**	**Avg**
Product price	15	22	1.47	9	18	2.00	8	13	1.63
Product functionality	19	38	2.00	15	29	1.93	11	25	2.27
Conformance quality	8	14	1.75	7	12	1.71	8	15	1.88
Time to market	9	14	1.56	6	11	1.83	5	9	1.80
Product innovativeness	16	35	2.19	11	22	2.00	9	19	2.11
Product customisation	7	14	2.00	3	5	1.67	2	3	1.50
Product range	4	10	2.50	3	8	2.67	3	7	2.33
Company reputation	3	8	2.67	3	8	2.67	2	5	2.50
Environmentally sound products	0	0		0	0		0	0	

Whilst there is a case to be made that most, if not all of the NPD strategies, support strategy at a business unit level, some NPD strategies are more important that others. Additional research needs to be carried out to determine which NPD strategies are most used to support business unit strategies. Conclusive results about the appropriateness of NPD supportive strategies cannot be drawn from the sample due to its small size and the large number of contingent variables. Foremost amongst the variables are the degree of innovativeness of the new products, the markets within which the business units operate, and the characteristics of the business units themselves (e.g., size, product range, personnel).

5.2.3 Performance Evaluation

Section 5.2 introduced the concept of measuring NPD performance across a wide range of NPD performance metrics. 'Market share of new products' was used by way of example in Table 5.1, with the full list of performance metrics that were examined being shown in Appendix M. In Table 5.5, the full list of performance metrics is shown, together with the reported change in performance over the previous three years in the respondent companies. The data in Table 5.5 have been separated into three groups, to simplify the analysis and presentation of the data contained therein. In all, 37 companies responded to this section of the survey, with a surprisingly large number using almost all of the performance measures listed.

Most companies provided data on 25 or more measures, with the least frequently used (10) being Indirect NPD costs.

Table 5.5: Performance Assessment

	No.	**Performance relative to 3 years ago**			
Performance Dimension		**Decr >20%**	**Decr ≤20%**	**Same**	**Incr**
Average NPD lead time	33	11	8	11	3
% Project overruns on lead time	34	9	4	16	5
Average time-to-market	33	11	8	11	3
% Project overruns on time-to-market	34	9	7	12	6
% Projects overrunning budget	24	4	3	15	2
Direct NPD costs	32	4	5	13	10
Indirect NPD costs	10	1	1	4	4
Number of engineering design changes	32	5	4	15	8
		Incr ≥20%	Incr <20%	Same	Decr
Capacity utilisation	32	5	9	11	7
No. of NP ideas evaluated	32	12	7	10	3
% of sales from new products	30	9	10	9	2
Market share of new products	30	10	10	7	3
% of NPD products completed successfully	33	6	8	16	3
No. of NP projects ongoing at any one time	33	6	10	12	5

		Impr≥20%	**Impr<20%**	**Same**	**Decl**
Product functionality	34	18	8	7	1
Conformance quality	33	16	7	8	2
Production cost of new products	34	12	12	6	4
Manufacturability/assembleability of NP	34	14	9	7	4
Level of modularisation of NP	32	19	4	9	0
NP design based on a common platform	32	18	3	8	3
Innovativeness of NPD function	34	14	9	10	1
Product customisation capability	34	11	8	10	3
Reputation of NPD function	34	12	8	12	2
Environmentally sound products	33	11	3	19	0

The majority of organisations (19 of 33) reported shorter lead times (11 + 8) and time-to-market (11 + 8) for their new products (57.6%). At the same time, a majority of organisations reported no improvement on projected lead times (16 + 5 or 61.8%) and project overruns on time-to-market (12 + 6 or 52.9%). These results may be a consequence of tighter projections being made in line with efforts to improve performance on these important criteria. As well, these improvements in lead-time and time-to-market for new products seem to have been at the expense of cost increases, with 71.9% of organisations (23 of 32) reporting no improvement, or an increase in direct costs increases, and 80% of organisations who tracked indirect costs (only 10) reporting no improvement or a worsening in performance with regard to indirect costs. Overall performance across the first group of metrics is very good, with very few companies reporting inferior performance, except in the category of direct cost increases. Still, the fact that a large number of organisations reported no improvement in performance is an indication of the need for such companies to have some direction when it comes to improving their NPD performance.

The second grouping of performance measures shows that most of the respondents had maintained or improved their NPD performance. Of the negative results, a decrease in capacity utilisation of 21.9% was the worst reported with 7 of 32 respondents represented. Whether this can be attributed to poor strategic planning, falling market demand, or gearing up for expansion cannot be determined. Such variation in responses should be expected, and specific relationships would need to be established on a case by case basis. For this reason, relevant issues that emerged from the quantitative survey portion of this research are examined in the three sets of detailed qualitative interviews that follow in the next chapter.

The third group of performance measures, beginning with product functionality relate specifically to the NPD function. Here, substantial performance improvement (>20%) is reported in a significant number of organisations (generally more than 33%) in all the performance measures listed, with very few reporting a decline in performance. The results reported here would be very much product dependent. The measures that show some poor performance areas are cost related (production costs, and manufacturability/assembleability). The literature shows that a

concentration on cost related measures is not conducive to improvement in innovation or new product development, so it is heartening to see a wide range of measures being employed in the respondent organisations (Alegre et al., 2006, Griffin and Page, 1996).

5.2.4 Summary of Analyses Regarding Research Question 1

The respondent organisations showed a preference for strategies that emphasised profitability, followed by innovation and growth. These objectives are interrelated and supportive. The strategies employed at the functional level for new product development were more broadly spread, but nevertheless supportive of the business unit strategies. The organisations used a wide variety of performance metrics to evaluate their new product performance, and overall, most organisations reported positive outcomes across a wide range of measures.

Establishing direct linkages between business unit, NPD function and performance outcomes would only be possible on a case by case basis, and given the diversity present in organisations, these linkages would be contingent on company demographics and conditions prevailing at the time. Factor analysis could provide some indication of which supportive strategies in the NPD function lead to better outcomes in performance, though, as was previously stated, the data sample is insufficient for such analysis. Whether this would provide a useful roadmap for other organisations to follow is problematic. Where performance improvement is required in a specific measurable activity, then the literature would suggest that this be given strategic emphasis (Kaplan and Norton, 1996a, Neely et al., 2001). Further, where NPD strategy is developed in support of business unit strategy, the organisation should be clear about which business unit objective this NPD strategy is intended to support, because in some instances the outcomes might be mutually exclusive. For instance a growth strategy may not necessarily be a short-term profitability strategy.

5.3 Research Question 2 – Management Action Programs

The second concept to be examined in the management of new product development processes in SMEs was the level of management involvement in improving NPD performance. Presumably a higher degree of involvement would lead to better outcomes, over time, across a range of NPD performance measures. A series of questions were developed to explore this relationship between the management of, and performance of the NPD process.

The questions relevant to management of the NPD process asked respondent organisations to comment a range of action programs that they had employed in order to improve this aspect of their business performance. Specifically, the survey questionnaire defined an action program as "*a major project aimed at producing considerable changes in the business unit's management practices and organisation, to which the business unit was devoting substantial resources and innovation effort, and on which is concentrated significant management focus and commitment.*" The definition was included to avoid information being supplied on action programs that constituted the normal course of business for organisations, and was designed to focus the respondents' attention on new NPD action programs that had been implemented in the recent past. For the purposes of the research, the recent past covered the previous three years.

In terms of these action programs, data were collected on the degree of effort that had gone into them during the previous three years, the perceived benefits that the business had accrued relative to each of the action programs, and the expected emphasis on these action programs for the next three years. The action programs that the respondents were asked to provide data on are shown in Appendix N.

In order to assess the effectiveness of these action programs, several criteria were used. Firstly, the respondents' assessment of the perceived benefit to the organisation of the action program could provide useful insights into the firm-specific value of the various action programs. Secondly, the expected emphasis on action programs would provide an indication as to the future strategic importance of

the action programs, with regard to the organisation's ongoing competitiveness in response to both internal needs and external competitive pressure. Finally, the respondents' answers concerning their NPD performance across a range of performance dimensions could be examined to form an overall assessment of the effectiveness of their action programs. These performance dimensions were covered when analysing research question one in section 5.2.3 of this chapter, and the same data will be used here to support the evaluation of the effectiveness of the SMEs various action programs.

5.3.1 New Product Development Action Programs

The degree of effort that the organisations put into a range of action programs was measured using a five-point Likert scale. A value of one meant that the organisation put no effort into the designated program, whilst a value of five implied a high degree of effort. An analysis of the thirty-seven valid responses is shown in Table 5.6. The comments that follow relate to the data in this table.

Table 5.6: Degree of Effort during the Last Three Years

Action Programme	Count	1	2	3	4	5	Mean Value
Formal management approaches or systems	35	4	11	8	5	14	4.39
New computer-aided design tools	36	5	2	8	14	7	3.84
Participation of marketing/sales in NPD	37	2	1	16	10	8	3.71
Self-managing empowered NPD teams	11	4	2	1	2	2	3.57
Formal CI programme	34	7	5	8	8	6	3.56
Use of cross-functional teams	11	0	3	4	1	3	3.36
Employee commitment/attitude towards change	11	2	3	1	4	1	3.33
Participation of production in NPD	35	4	7	11	9	4	3.32
Flexible, multi-disciplinary NPD staff	33	4	8	8	9	4	3.31
Employee skills	37	1	9	14	8	5	3.25
Administrative routines	11	4	2	3	1	1	3.14
Customer participation in NPD	37	3	9	16	5	4	3.12
Concurrent Engineering	33	10	7	8	7	1	3.09
Involvement of universities and research institutes in NPD	34	10	8	9	5	2	3.04
Supplier participation in NPD	35		9	10	9	0	3.00
Benchmarking other companies' NPD practices and performance	35	21	6	4	4	0	2.86
New non-computerised tools and techniques, e.g. QFD, FMEA	35	14	10	6	5	0	2.76

The action programs listed in Appendix N have been arranged in Table 5.6 in order of the greatest degree of effort, on average, that organisations have put effort into those action programs. The mean value was calculated by multiplying the degree of effort (1 to 5) by the number of organisations reporting that value, and then dividing the total by the number of firms that participated in those action programs. Firms that reported a value of 1, i.e., no effort were not included for the purposes of arriving at the mean value because they did not participate in the programs mentioned.

Whilst most respondents reported some degree of effort across the range of action programs, there were several action programs where there was a low level of involvement. Only seven firms reported any level of effort through self-managed teams (eleven responses, but four of those reported no effort), eleven used cross-functional teams, nine employed change management, seven used action programs involving administrative routines, and only fourteen put effort into action programs that included the benchmarking of other companies' NPD practices. This low level of involvement in team-based improvement efforts in SMEs may be due to the much smaller management teams that exist in such organisations, and where often one or a few managers are responsible for a broad range of activities, but it is certainly worthy of further research. The lack of benchmarking programs to improve NPD performance could be due to the uniqueness of individual SMEs, or the difficulty in being able to identify benchmarking partners. It could also be a result of many SMEs only being a small part of the overall NPD process, where requirements are often dictated by the demands of the customer for whom they are producing.

Looking at those programs where a larger number of firms applied their efforts, some interesting speculation can be made. Firstly, the greatest degree of effort went into formal management approaches. These include such things as total quality management, ISO9000, and project management, concepts with which most managers in SMEs would be familiar. The scope of such activities is also broadly based, so it is reasonable to expect that action programs of this type would consume a fair amount of an organisation's resources. In this instance, the findings support preliminary expectations of a high degree of management commitment.

The second ranking action program in terms of the 'degree of effort' was new computer-aided design tools. This includes such things as computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE). There are many possible reasons why such action programs should rate so highly. Firstly, the acquisition of such items would represent a significant cost to SMEs, as would the management time devoted to acquiring the necessary skills to use such tools. Secondly such costs could be clearly identified. Thirdly, SMEs might be expected to acquire such systems where they are part of a larger NPD network, where for instance they manufacture new products to a customer's design. In such instances, the SMEs would be expected to have systems compatible with their customers. Some may wish to acquire such competencies to obtain a competitive advantage, or to secure their relationships with valued customers. The driving force behind the implementation of the various action programs is worth further investigation.

The third ranking action program according to the survey data was the participation of marketing/sales in new product development. The literature on new product development would certainly support a high degree of customer involvement in the process. In larger organisations such activity might be encompassed if formal approaches like quality function deployment, an activity that interestingly ranked lowest amongst the NPD action programs carried out in SMEs. For smaller SMEs, the voice of the customer in the NPD process would seem, according to the survey data, to be coming through the involvement of sales and marketing people.

Having identified three action programs that consume a relatively high level of the resources of SMEs when it comes to improving their new product development processes, the next step is to look at the effectiveness of these various programs.

5.3.2 Effectiveness of New Product Development Action Programs

In order to evaluate the effectiveness of the NPD action programs, the respondent companies, were asked to rate the benefits, by way of improved performance, that had resulted from the various projects. Their effectiveness rating was given using a

five-point Likert scale where a value of 1 represented a low benefit, and a value of 5 indicated a high benefit. The action programs have been sorted in Table 5.7 in order of the greatest perceived improvement in performance, on average, that organisations have obtained from their efforts. This mean value was calculated by multiplying the level of benefit (1 to 5) by the number of organisations reporting that value, and then dividing the total by the number of firms that participated in those action programs. Firms that reported a value of 1, i.e., low benefit, were included for the purposes of obtaining a mean value. It is worth noting that some organisations that reported no significant effort in a particular action program during the previous three years nevertheless reported on the level of benefit that their organisation had obtained from such programs. The information on benefits provided by such organisations was retained in the data presented in Table 5.7 for the reasons mentioned below.

Firstly, organisations reported a benefit where no major projects were undertaken in the previous three-year period because some benefits were derived from programs established earlier than the previous three years. Secondly, some of the companies had mature programs that did not require a substantial commitment to maintain, and which delivered some benefit to the organisation. Thirdly, the values reported had no significant impact on the ranking of action programs as reported in Table 5.7.

Table 5.7: Benefits Derived from New Product Development Action Programs

Action Programme	Count	1	2	3	4	5	Mean Value
New computer-aided design tools	33	3	4	10	7	9	3.45
Formal management approaches or systems	32	4	4	9	5	10	3.41
Formal CI programme	26	0	6	7	10	3	3.38
Flexible, multi-disciplinary NPD staff	30	3	5	8	8	6	3.30
Use of cross-functional teams	10	1	2	2	3	2	3.30
Employee skills	34	2	4	14	10	4	3.29
Participation of marketing/sales in NPD	36	3	3	15	11	4	3.28
Participation of production in NPD	31	3	4	10	10	4	3.26
Employee commitment/attitude towards change	9	1	1	3	3	1	3.22
Self-managing empowered NPD teams	8	1	2	2	1	2	3.13
Customer participation in NPD	35	6	5	10	9	5	3.06
Supplier participation in NPD	33	6	6	10	11	0	2.79
Involvement of universities and research institutes in NPD	29	7	4	11	4	3	2.72
Concurrent Engineering	28	7	7	7	6	1	2.54
Administrative routines	9	2	3	3	1	0	2.33
New non-computerised tools and techniques, e.g. QFD, FMEA	31	13	8	4	4	2	2.16
Benchmarking other companies' NPD practices and performance	25	13	3	6	3	0	1.96

Generally speaking, the benefits that accrued from the various action programs matched the effort (Table 5.6) that went into them. The two top rated programs in terms of effort were also the two top rated in terms of benefit, albeit with the order reversed, though the difference in mean values for benefits was marginal at 0.04. Further the bottom two ranked programs in terms of effort were also ranked at the bottom in terms of benefit. In between, program effort and benefit were mixed, but the reported differences, based on means were relatively small. The correlation coefficient between the two sets of figures is 0.738, indicating a strong match between return on effort associated with the various action programs.

5.3.3 Future Action Programs

Whilst the companies reported a level of satisfaction with their new product development action programs, if we take the reasonable assumption that a close match between benefit and effort provides an indicator for this, should the further assumption be made that they will continue to put resources into the same types of action programs? The answer to this should not automatically be yes. It is reasonable to expect that an organisation would want to focus its efforts on those areas where there is a perceived weakness, or where it wishes to maintain a level of performance that gives it a competitive advantage. This reasonable assumption presents a danger that should be recognised in research of this nature, namely, that the results are specific to a particular period in time in which they are collected. Some action programs may be ongoing, but some may be cyclical, or a response to external contingencies such as competitive pressures, or the demands of customers. This issue will be explored when analysing the in-depth interview data in Chapter 6 (Questions 11 through 14, and 17, in the qualitative survey). From the current data set, the responses on which programs would be targeted in the next three years are presented in Table 5.8. The mean values were calculated in the same manner as was used in Table 5.6.

Table 5.8 Expected Emphasis in the Next Three Years

Action Programme	Count	1	2	3	4	5	Mean Value
New computer-aided design tools	34	5	2	4	14	9	4.03
Participation of marketing/sales in NPD	36	1	1	8	18	8	3.94
Formal management approaches or systems	33	3	3	9	6	12	3.90
Employee skills	35	1	1	9	19	5	3.82
Participation of production in NPD	34	1	4	6	16	7	3.79
Use of cross-functional teams	11	0	1	4	3	3	3.73
Employee commitment/attitude towards change	10	1	1	3	3	2	3.67
Flexible, multi-disciplinary NPD staff	31	2	3	9	13	4	3.62
Customer participation in NPD	36	3	3	12	14	4	3.58
Self-managing empowered NPD teams	10	2	2	2	2	2	3.50
Formal CI programme	32	4	2	11	10	5	3.50
Administrative routines	10	1	3	1	3	2	3.44
Supplier participation in NPD	35	5	6	11	12	1	3.27
Involvement of universities and research institutes in NPD	32	7	8	7	6	4	3.24
Concurrent Engineering	32	4	8	9	8	3	3.21
New non-computerised tools and techniques, e.g. QFD, FMEA	31	10	6	9	4	2	3.10
Benchmarking other companies' NPD practices and performance	32	8	8	8	8	0	3.00

The top three programs for the next three years, were also ranked in the top three for the previous three years, though formal management approaches has shifted from position one to position three. Benchmarking and new non-computerised tools again appear at the bottom at they were in the preceding three years in terms of degree of effort. In between, there is some shift in rankings based on averages, but this is relatively minor. The correlation coefficient between the effort put into NPD action programs in the previous three years, and that expected to be put into similar programs in the coming three years is 0.796, which is even higher than the correlation between effort and benefit that was discussed earlier. Is this a case of simply carrying on as before by putting future effort into those programs that have been actioned in the past? Not necessarily, perhaps these business units determine their future action programs based on the level of benefit that they have obtained from past programs. In order to evaluate this supposition, a correlation value was obtained between the mean values for the benefits derived from past programs, and

the mean values that were calculated for the expected emphasis on future NPD action programs. The correlation coefficient was even higher at 0.894, and is an indication that past successes do inform decisions on where to allocate resources for future projects. In other words, valuable lessons from past action programs, reinforced by the perceived benefits of those programs, encourages organisations to continue to use them. In terms of the literature reviewed on new product development practices, this provides some evidence that SMEs are developing capabilities relevant to their new product development processes. This evidence of learning within SMEs will also be further examined when reviewing the data obtained through the in-depth interviews.

Relating the individual action programs to performance outcomes within individual companies is beyond the scope of this research. Given the number of companies involved, (sample size n=37), the number of action program variables (n=17), and the number of performance dimensions (n=27), a meaningful analysis is not possible. These relationships can be better explored at the business unit level.

5.3.4 Summary of Analyses Regarding Research Question 2

The respondent SMEs demonstrated a low level of involvement in team-based activities relative to that reported in the literature for larger organisations with successful new product development programs (Lynn, 1998). Further, these SMEs seemed more comfortable directing their efforts towards improving their processes through formal management approaches, and continuous improvement programmes, but without the need to look beyond their own boundaries for guidance. In this regard, benchmarking other companies new product development processes ranked lowest in terms of action programs. When it came down to deciding which programs to pursue in the future, the organisations were strongly influenced by their past programs. This is perhaps indicative of a degree of confidence in pursuing programs with which they had experience. An even stronger influence came from past programs that were perceived to have generated significant benefits for the organisation. Both are indicative of learning occurring within the organisations with regard to their new product development action programs. A negative outcome of

such practices is the lack of incentive to explore new avenues of improvement. Such behaviour may be constrained by resource limitations, both time and money. For this reason, SMEs should be encouraged to develop their external linkages. Sadly, such programs appear to reside at the bottom of the list with regard to SME action programs.

5.4 Research Question Three - Management of NPD Projects

This section examines whether a more systematic approach to the management of NPD projects in SMEs leads to better outcomes in terms of the degree of innovativeness, and improvement in NPD process performance.

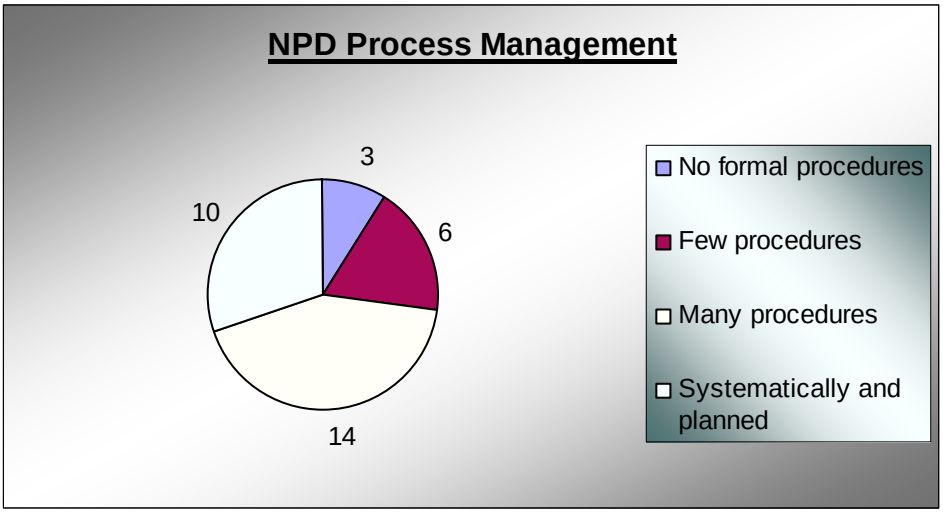
The overwhelming position taken by management literature is that formal processes provide the basis for improvement and that a systematic approach produces more consistent outcomes (Griffin and Page, 1993, Mahajan and Wind, 1992, Tomkovick and Miller, 2000, Trott, 2005). In large organisations, systematic product development processes are employed more often in firms that are acknowledged as best practice firms. No significant research has been conducted into the extent or impact of systematic or formal NPD processes in small to medium sized firms.

The quantitative data collected for this research allows a preliminary examination of the impact of NPD process choices on performance in SMEs. Data for this analysis were provided by thirty-three firms. Their responses to a range of questions concerning management of their NPD projects, the innovativeness of their NPD function, and outcomes in terms of project completions and the reputation of the NPD function were analysed.

5.4.1 New Product Process Management and Innovativeness

The first issue to be examined was management of the new product development process. Firms were asked to describe the way NPD projects were managed in their business units. Their responses are shown in Figure 5.2.

Figure 5.2: NPD Process Management



The same firms were asked to rate the innovativeness of their business unit's new product development function as either innovative, a fast follower, or a late follower. These responses were compared in order to determine whether a systematic, formal approach to NPD projects had a relationship to the level of innovativeness that the firms reported. Innovativeness in this context was assessed on whether the organisation was a leader or follower in terms of the introduction of a product into the market. The comparative data is shown in Table 5.9 below.

Six of the firms without strongly systematic NPD processes considered themselves to be innovative (Leaders), whilst nineteen of the twenty-four systematic firms considered themselves to be innovative. Analysis of the data in Table 5.9 using a chi-squared (□ □) test indicated that the innovativeness of the respondent firms did not appear to be affected by the approach taken to the management of NPD projects, whether the approach was informal or systematic. Research carried out with large organisations established a connection between a formal new product development process, the ability to bring products to market on time, and successful new product outcomes (Griffin and Page, 1993, Tomkovick and Miller, 2000, Trott, 2005).

Table 5.9: Innovativeness and NPD Management

Observed Frequencies			
	Process		
Innovativeness	**Informal**	**Formal**	**Total**
Leader	**6**	**19**	**25**
Follower	**3**	**5**	**8**
Total	**9**	**24**	**33**

Expected Frequencies			
	Process		
Innovativeness	**Informal**	**Formal**	**Total**
Leader	6.8	18.2	25
Follower	2.2	5.8	8
Total	9	24	33

The actual and expected frequencies were used to test the null hypothesis that there is no difference between the two population proportions. The results as shown in table 5.10 indicate that we cannot reject the null hypothesis that there is no difference. Based on this analysis, we cannot assert that the formality or lack thereof in managing new product development activities within SMEs has an impact on innovativeness. It should be noted that the minimum frequency in any category should be at least five. Where this condition is not met the results are retained for descriptive purposes, however results for these groupings should be treated with caution.

Table 5.10: Chi-squared Analysis of Innovativeness and NPD Management

Data	
Level of Significance	**0.05**
Number of Rows	2
Number of Columns	2
Degrees of Freedom	1

Results	
Critical Value	**3.841459**
Chi-Square Test	**0.556875**
***p*-Value**	**0.455522**
Do not reject the null hypothesis	

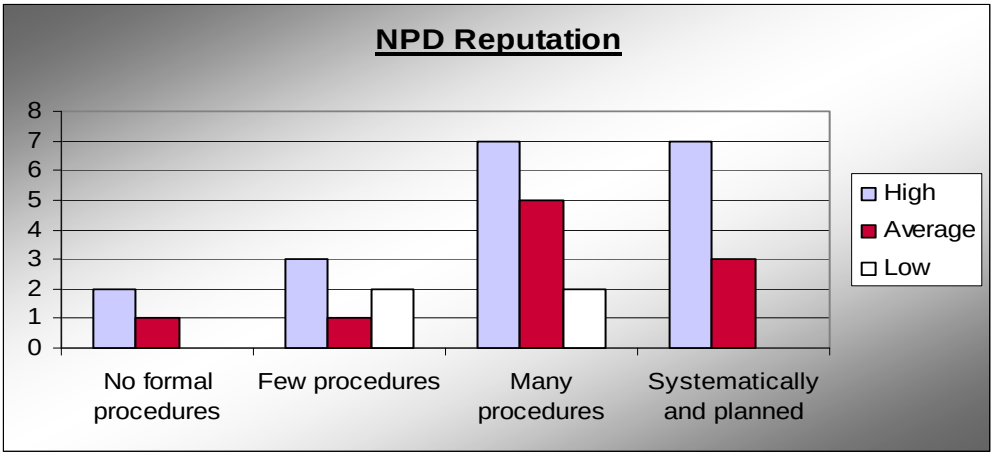
5.4.2 New Product Process Management and Performance

The second issue examined was whether the approach taken in the management of NPD projects would impact on project outcomes. Certainly best practice large firms generally employ formal new product development processes, but research into SMEs has not yet explored NPD practices and performance to a great extent. When it comes to measuring project success, different measures tend to be favoured depending on the newness of the product, which could range from repositionings, to new-to-the world. The measures of success could fall under three broad categories, namely, customer-based, financial, or technical performance. Customer-based measures dominate, so one measure of successful outcomes used in this study was the reputation of the NPD function with customers and competitors. The second measure used to evaluate project performance was time-to-market, which many researchers acknowledge as a key variable in new product success (Allocca and Kessler, 2006, Cooper, 1994, Cooper and Kleinschmidt, 1994, Griffin, 1993, Rosenau, 1988, Wheelwright and Clark, 1992b).

5.4.3 Reputation for New Product Development

Each organisation was asked to rate the reputation of its new product development function with its customers and/or competitors as either high, average, or low. The responses are presented in Figure 5.3 below. Five of the nine firms without strongly systematic NPD processes considered their reputation to be high, whilst fourteen of the twenty-four systematic firms considered their reputation to be high. The reputation of the respondent firms does not appear to be affected by the approach taken to the management of NPD projects, whether it is informal or systematic.

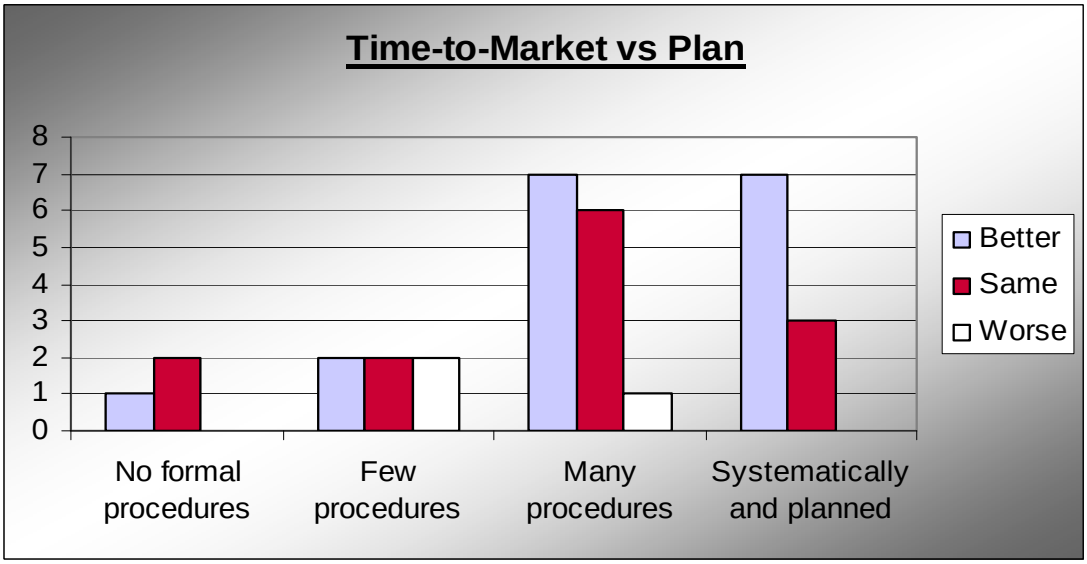
Figure 5.3: NPD Reputation



5.4.4 Time-to-Market Performance

Time-to-market is the time between starting the development of a new product and its launch in the market place. The shorter this time period, the greater the likelihood of the new product launch being successful. Analysis of collected data indicates that time-to-market measures for these firms appear to be improved by a systematic approach to the management of NPD projects.

Figure 5.4: Time-to-Market Comparison



5.4.5 Summary of Analyses Regarding Research Question 3

Small to medium-sized firms exhibit great diversity in the products and services they offer. The processes and functions they employ to produce these goods and services, whilst generally recognisable in broad terms, also display great diversity. This diversity and variety comes across when analysing the data. Given the small sample size used in this exploratory research, it is impossible to generalise. The approach taken by SMEs in managing their new product development processes was analysed, and the findings mirrored the disparate nature of the respondents.

The innovativeness of these firms did not appear to be affected by the way in which their NPD projects were managed. The performance of the firms, when assessed across two dimensions, showed mixed results when compared against the process used to manage NPD projects. In terms of the firm's reputation, it appeared to be independent of project management procedures. Fifty-five percent of firms with no formal NPD processes, and fifty-eight percent of firms with formal NPD processes reported a high reputation for NPD project management. It is possible that in SMEs, reputation rests more with interpersonal relationships between firm personnel and their customers.

The way in which NPD projects were managed appeared to have a significant impact on reducing the average time-to-market for new products. Whilst the difference seems substantial, the sample size is insufficient to statistically validate whether the difference is significant.

5.5 Research Question Four – Measuring NPD Performance

Dixon, Nanni and Vollmann (1990) examined the relationship between strategy, actions and performance measures and asserted that only by closely aligning the three could strategies be effectively monitored and achieved. This relationship was discussed in research question one. Kaplan and Norton (1996b) stated that an effective performance measurement system, such as their balanced scorecard, was

an essential component of a strategic management system. Simply stated, they see a circular relationship between strategy and performance measurement, which goes beyond the top-down relationship that was emphasised in the work of Dixon et al., (1990). In research question four this suggested relationship between performance measurement and outcomes, and strategy, is explored in the context of the new product development and innovation practices in small to medium-sized manufacturing firms.

5.5.1 Does Performance Measurement Inform Strategy in SMEs?

In Chapter three the literature on performance measurement established that performance measurement should inform strategy. One would expect therefore, that where performance measurement demonstrates an unsatisfactory outcome against some stated goal, an effective strategic management system would identify such areas to be targeted for attention in future periods.

In the quantitative part of this research, respondent firms were asked to describe their new product development performance across twenty-seven different performance dimensions (Appendix M). Two of these were analysed for the purpose of evaluating whether or not actual performance outcomes influence the choice of future action plans. The two performance dimensions examined were:

1. Time-to-market - the time between starting the development of a new product and its launch in the market place, and
2. Conformance quality - the extent to which the product meets the customer's technical specifications/expectations.

These were chosen because they were identified in the literature as being vital to new product success (Curtis and Ellis, 1998, Griffin, 1993).

The companies that provided performance data on these dimensions were separated into two groups – those that achieved a performance improvement, and those who reported that their performance remained the same or was worse than in the previous

three years. The responses of these two groups were then compared to their responses regarding action plans aimed at improving performance on time targets and quality targets respectively, for the next three years. The object of the analysis was to determine whether those business units that performed poorly would change their strategic focus, via the use of different action programs, in order to improve their performance in the future.

5.5.1.1 Time-to-Market Performance Dimension

Thirty-three firms reported on their performance in this area. Of these, thirty-two also provided data on the importance of time targets in their strategic plans for the next three years. The firm that did not provide data on time targets was omitted from the comparison. Compared to their performance three years ago, eighteen reported an improvement, while fourteen stated that their performance had remained the same, or had worsened.

To determine the importance of time targets in future improvement efforts, firms were asked to rank the level of importance of action plans aimed at improving their time targets. The scale used was a four point Likert scale with a value of 1 meaning not important, and a value of 4 being of critical importance. The comparative data between recent performance compared to three years ago, and future effort is shown in Table 5.11.

Table 5.11: Time-to-Market: Past Performance and Future Action

		Future action plans for this performance dimension			
Recent Performance		1. Not Important	2.	3.	4. Of critical importance
Improve > 20%	11	-	1	9	1
Improve >10%	7	-	2	2	3
No change	11	-	3	5	3
Worse	3	-	2	1	-

The data in Table 5.11 clearly shows that none of the organisations considered time-to-market targets as unimportant. One would expect though, that, on the assumption that performance informs strategy, as established from the literature review, the

criticality of time-to-market would be higher in firms where the recent past had seen a worsening, or no change in performance. The data however, is less clear on this aspect. Only one firm of the eleven that had shown significant improvement in the past (>20%) rated the performance dimension of critical importance, perhaps because those firms had already attained a satisfactory level of performance with regard to this key variable. However, none of the three badly performing firms rated it of critical importance, which is clearly contrary to expectations. To gain a better overall view of this supposed relationship between measurement and future action plans, the data in Table 5.11 was aggregated into two groups as discussed in the previous section. As well, the data on future action plans was weighted according to the level of criticality reported, i.e., not important = 1, 2 = 2, 3 = 3, and of critical importance = 4. The averaged responses for each of the two groups are shown in Table 5.12.

Table 5.12: Time-to-Market: Past Performance and Future Action – Averaged Responses

Performance Dimension		
Average time-to-market	Number	Importance in future action plans
Improvement	18	3.06
Same or worse	14	2.86

At first glance, the data presented in Table 5.12 indicate that for this sample of SMEs, the poor performers with respect to time-to-market intend to give relatively less emphasis in the future to action plans that will improve this important performance dimension. Another way to test whether there is a difference between the 'improvers' and 'non-improvers' is to divide the responses on future action plans into 'low-level' and 'significant', and then compare the numbers against those reporting an improvement or otherwise, using a chi-square test. The summary data for this test is shown in Table 5.13.

Table 5.13: Time-to-Market Performance

Observed Frequencies			
	Performance		
Activity	**Improvers**	**Non-Performers**	**Total**
Significant future activity	**15**	**9**	**24**
Low level of activity	**3**	**5**	**8**
Total	**18**	**14**	**32**

Expected Frequencies			
	Performance		
Activity	Improvers	Non-Performers	Total
Significant future activity	13.5	10.5	24
Low level of activity	4.5	3.5	8
Total	18	14	32

We can use these actual and expected frequencies to test the null hypothesis that there is no difference between the two population proportions. The results as shown, in Table 5.14, indicate that we cannot reject the null hypothesis that there is no difference.

Table 5.14: Chi-square Analysis of Time-to-Market Performance

Data	
Level of Significance	**0.05**
Number of Rows	2
Number of Columns	2
Degrees of Freedom	1

Results	
Critical Value	**3.841459149**
Chi-Square Test Statistic	**1.523809524**
***p*-Value**	**0.217044022**
Do not reject the null hypothesis	

The data analysis indicates that past performance does not seem to make a difference in terms of influencing action programs that will improve time targets in the future. Based on this analysis, we cannot assert that performance measurement outcomes feed back into future strategic plans and action programs for the performance dimension of time-to-market. Why this should be so is uncertain. It

could be the absence of adequate review mechanisms, even where measurements are taken. It could also be resource constraints such as, time, money, and personnel limitations, which might impact in a variety of ways. In the qualitative analysis that is done in chapter 6, questions 20 and 21 seek to obtain information that might shed light on whether performance measurement feeds back into strategic planning activities.

5.5.1.2 Quality Performance Dimension

Quality means different things to different people and it has many different aspects and characteristics. For the purposes of this analysis the emphasis will be on conformance quality. Conformance quality was defined in the survey questionnaire as "*the extent to which the product meets the customer's technical specifications/expectations*". Measurement of this performance dimension was compared to action plans that emphasised quality targets. The analysis followed that employed when examining the time-to-market performance dimension.

Thirty-three firms reported on their performance in this area. Compared to their performance three years ago, twenty-seven reported an improvement, while six stated that their performance had remained the same, or had worsened.

To determine the importance of quality targets in future improvement efforts, firms were asked to rank the level of importance of action plans aimed at improving quality. The scale used was a four point Likert scale with a value of 1 meaning not important, and a value of 4 being of critical importance. The comparative data between recent performance, over the previous three years, and future effort is shown in Table 5.15.

Table 5.15: Conformance Quality: Past Performance and Future Action

		Future action plans for this performance dimension			
Recent Performance		1. Not Important	2	3	4. Of critical importance
Improve > 20%	24	-	4	10	10
Improve >10%	3	-	-	3	-
No change	4	-	-	2	2
Worse	2	-	-	1	2

The data in Table 5.15 shows that none of the organisations considered quality targets as unimportant. If one were to assume that performance informs strategy, the emphasis on quality should be higher in firms where the recent past had seen a worsening or no change in performance. All six firms that had shown poor performance in the past, rated the quality conformance performance dimension very highly, so too did most of the better-performed firms. Indeed, twenty of the 24 highest performers in terms of improvements in quality conformance also indicated a value of three or four when rating the importance of quality targets in their future action plans. To gain a better overall view of the relationship between measurement and future action plans in SMEs, the data in Table 5.15 was aggregated into two groups as discussed in the previous section. As well, the data on future action plans was weighted according to the level of criticality reported, i.e., not important = 1, 2 = 2, 3 = 3, and of critical importance = 4. These responses were then averaged for each of the two groups. The results are shown in Table 5.16.

Table 5.16: Conformance Quality: Past Performance and Future Action – Averaged Responses

Performance Dimension		
Conformance Quality	Number	Importance in future action plans
Improvement	27	3.22
Same or worse	6	3.50

At first glance, the data analysis presented in Table 5.16 indicates that for this group of SMEs, the six poor performers with respect to time-to-market intend to give more emphasis in the future to action plans that will improve this performance dimension, relative to the better performing business units. Another way to test whether there is a difference between the 'improvers' and 'non-improvers' is to divide the responses on future action plans into 'low-level' and 'significant', and then compare the numbers against those reporting an improvement or otherwise, using a chi-square test. The summary data for this test is shown in Table 5.17.

Table 5.17: Chi-square Analysis of Conformance Quality Performance

Conformance Quality	Improvers	Non-Performers	Total
	Actual Frequencies		
Significant future activity	23	6	29
Low-level of activity	4	0	4
Total	27	6	33
	Expected Frequencies		
Significant future activity	23.7	5.3	29
Low-level of activity	3.3	0.7	4
Total	27	6	33

We can use these expected and actual frequencies to test the null hypothesis that there is no difference between the two population proportions. The results shown in Table 5.18 are close to what were expected, and indicate that we cannot reject the null hypothesis that there is no difference between high performers and low performers with respect to future action plans aimed at quality improvements.

Table 5.18: Results of Chi-square Analysis

Critical Value	3.841455338
Chi-Square Test Statistic	1.011494253
p-Value	0.314545407
Do not reject the null hypothesis	

Based on this analysis, we cannot assert that performance measurement outcomes feed back into future strategic plans and action programs for the performance dimension of conformance quality.

5.5.2 Summary of Analyses Regarding Research Question 4

For performance dimensions, time-to-market, and conformance quality, there was no significant difference in expected future action programs as a result of outcomes from the previous three years. The group that performed relatively poorly had not targeted those poor performance areas for future effort to a greater extent than the group that achieved good improvement. Both groups expressed the need to focus on action programs for time-to-market and conformance quality, with twenty-four of

thirty-two stating that they considered time-to-market action programs of significant importance, and twenty-nine of thirty-three saying the same about conformance quality. The data do not seem to indicate that past performance outcomes lead to discernible differences in the importance of future action programs. In other words, performance measurement does not appear to inform future strategic choices. On the other hand, as was noted in the data discussion on research question two, the benefits derived from previous action programs do have an influence on future action programs.

5.6 Summary and Key Findings

This concludes the discussion of the quantitative data as it relates to the four research questions. Data pertinent to each of the research questions were analysed and conclusions developed. Conclusions were presented at the end of each section and the key research findings for each research question are now summarised as follows:

- **Research question one:** The data indicate that a variety of NPD strategies are employed to support various business unit strategies. Using the aggregate data from all companies only provided an indication of the main strategies employed. It was not possible to determine whether the individual companies NPD strategic choices supported their business unit strategy. Such conclusions would need to be determined on a case by case basis.
- **Research question two:** Management involvement to improve NPD performance tended to be technologically driven and functionally based. Very few organisations used team-based activities to develop NPD capabilities, which is at odds with what the literature deems to be best practice. Further little attention was given to building external linkages, thus limiting opportunities to explore technologies outside the organisations existing capabilities.
- **Research question three:** Managing new projects could be viewed from the perspective of companies that employed a systematic approach as opposed to those that employed an informal approach. The data indicate that a systematic approach to managing NPD projects had a significant impact on time-to-market performance. The approach taken in managing NPD projects appeared to have

no identifiable impact on the customers' perceptions on the firm's reputation to deliver new products to their specifications.

- **Research question four:** SMEs did measure outcomes of NPD projects to evaluate customer satisfaction and profitability, but performance measures did not appear to influence future strategic decisions. Further, performance metrics seemed to have no influence on action programs. The effectiveness of management action programs did not seem to be evaluated.

In the following chapter this examination continues with an analysis and review of the qualitative data.

Chapter 6

Qualitative Data Analysis

6.1 Introduction

In addition to the quantitative survey data collected for this research, a series of in-depth interviews were conducted at three participating business units, with a view to obtaining a more detailed understanding of the new product development processes in SMEs. During the quantitative data collection process, the various business units were asked whether they would be willing to participate in a series of interviews. On the basis of those responses, three business units representing a cross-section of the companies involved in terms of size were chosen. In this chapter the responses of those participants are examined in the context of the four research questions that are the focus of this thesis. This chapter begins with a description of the participants, and is followed by a discussion of the qualitative interview proforma, before presenting the analysis of the interviews.

6.2 Participating Organisations

The organisations that participated in the qualitative surveys were all involved in the manufacture of metal products of varying complexity. All three companies were ISO9000/1 quality endorsed.

Table 6.1: Qualitative Interview Participating Business Units

	Company A	**Company B**	**Company C**
Ownership	Private company. Shares tightly held by management	Subsidiary of large Australian exporter.	Private company. Shares tightly held by management
Size – employees	50	110	190
Market	Price-sensitive low margin. Small customer base	High value, medium volume precision engineering. Niche market	Competitive market. Sheet Metal manufacturer for consumer market.
Principal Product	High voltage switchgear	Precision toolmakers	Office storage products
Industry Classification	2439 Other Electrical Equipment Manufacturing	2463 Machine Tool and Parts Manufacturing	2240 Sheet Metal Product Manufacturing

Within each of these business units, three interviews were conducted with personnel representing the manufacturing/operational function, the sales/marketing function, and the design/R&D function. The titles assigned to the various personnel tended to vary between firms, but the roles of the interviewees fitted the commonly accepted functional classifications. The designations of the various interviewees in each organisation are shown in Table 6.2. In the remainder of this chapter, where specific responses are quoted, the relevant respondent will be referred to by an alpha-numeric. The letter refers to the company, and the number refers to the functional classification of the respondent. For example, a response from the manufacturing/operations function in company B would be designated as 'B2'.

Table 6.2: Qualitative Interview Participants' Titles

	Company A	**Company B**	**Company C**
Sales/Marketing 1	Sales & Marketing Manager	Sales Executive	General Manager Sales & Marketing
Manufacturing/Operations 2	Production Planner	Production Coordinator	General Manager Operations
Design/R&D 3	Technical Manager	Development Manager	Senior Designer

6.3 Qualitative Interview Proforma

As explained in the methodology chapter, the qualitative interview proforma was developed concurrently with the quantitative questionnaire in order to obtain a more detailed picture of the internal processes associated with developing new products within SMEs. This qualitative interview proforma (Appendix M) provided structure to the interviews and offered the prospect that issues relevant to the four research questions would emerge. The people who participated in the qualitative interviews had not been exposed to the quantitative survey instrument prior to the interviews. After a few descriptive questions had been asked, the interviewees were asked to comment on a range of issues relevant to those research questions. Table 3 lists the numbers of the various questions and how their answers might relate to the research questions.

Table 6.3: Research Questions and the Qualitative Interview Questions

Research Question	Qualitative Interview Question Numbers
Research Question 1 Is the business unit's competitive strategy supported by its NPD strategy?	4-7
Research Question 2 What is the level of management involvement in improving new product development processes and performance?	11-17, 27
Research Question 3 How should SMEs manage their new product development projects?	22-27
Research Question 4 Do SMEs measure NPD performance, and does such measurement influence strategy?	8-10, 18-21, 27

Just as the research questions are inter-related, so too the qualitative survey questions have the potential to attract responses to one or more of those research questions. For instance, those questions designed to obtain data on measures of NPD performance and their influence on strategy (research question four) had the potential to provide data relevant to research question one. In reviewing the responses obtained during the interviews, this was kept in mind and the full range of responses were analysed in order evaluate the approach taken by SMEs to the management of their new product development processes. In presenting the qualitative data analysis in the rest of this chapter, the structure used in chapter five to review the quantitative data is followed. Each research question is looked at separately. The theory relevant to each research question is briefly discussed. This provides us with an expectation, based on the literature review, of what best-practice firms should be doing. The literature dealing with new product development was principally about NPD practices in large organisations so it is possible that differences will emerge when reviewing the practices of SMEs. As well, the series of interviews covered in this chapter are specific to Australian manufacturing SMEs, and any conclusions based on these interviews may not be generalisable beyond these companies.

6.4 Research Question One – Strategic Alignment

Is the business unit's competitive strategy supported by its NPD strategy?

The new product development literature review established that better performing organisations have an NPD strategy that is aligned with and closely supports the business unit's strategy (Christensen, 2003, Trott, 2005, Griffin, 1997). In the previous chapter, the respondents to the quantitative survey provided a variety of answers on their choices of Business Unit competitive strategies (Table 5.2) and their NPD competitive strategies (Table 5.3). The clear winner for their NPD strategies was product functionality. This was defined in the quantitative survey as "the extent to which the product meets the customer's functional specifications/expectations." The second most significant strategic approach indicated by the quantitative survey respondents was product design/innovation which was defined as "the looks, feel, styling of the product, but also technological advance." Table 5.4 showed the extent to which the top three business unit strategies were supported by the various NPD strategies. Whilst the findings from the quantitative data are useful, they do little to explain how the link between business unit strategy and new product development strategy are managed in small to medium-sized businesses. To explore this process three interviews were conducted in each of three targeted SMEs as outlined in the previous section. In the following sections the responses to the interviews are discussed on a company by company basis. Observations drawn from the qualitative data are made for each research question. This procedure is followed for all four research questions.

Two issues were explored in an effort to evaluate whether business unit strategy and NPD strategy are aligned in SMEs. Firstly, the respondents in each organisation were asked to nominate the business strategy and the NPD strategy. Secondly, they were asked to explain who determined these strategies. Often the phrases used by the respondents did not fit the wording offered in the quantitative survey. For instance A1's response to the question on business unit strategy was,

> "*Well, basically, the company is formed to make money, and we do whatever we need to do to make money.*"

Whilst the answer may demonstrate a lack of understanding of strategy, it would not be unreasonable to assume that this respondent sees profitability as the business unit's competitive strategy. The series of interviews are presented and discussed company-by-company. It was noticeable that the complexity and sophistication of answers increases with increasing company size, although whether this observation would hold across a larger sample cannot be verified.

6.4.1 Analysis of Company A Responses

Company A manufactured electrical switchgear and related products for a small customer base (about 20 principal customers). Its product range included high-voltage disconnectors, earthing switches, and electrical carrying components. As well as manufacture of these items, the company also provided consultancy services, site installations, periodic maintenance and emergency repairs. It was looking to expand its sales in a price-sensitive low-margin industry.

The three responses from Company A to the question on business unit strategy indicate a lack of knowledge as to what a business strategy is. They are indicative of different functional perspectives. A1's response indicated a profitability emphasis. A2 responded in terms of competitive advantage, and mentioned shorter lead times and flexibility. A3 spoke of competing on "*price, delivery and after sales service. And the quality of the product as well.*" When asked about the NPD strategy, A1 said,

> "*Well, the customers are always wanting different things,*"

which indicates a product customisation strategy would be relevant. A2 said,

> "*I don't spend a lot of time in the product development strategies, I mainly get it after the engineering boys have finished with it and basically make this … Which can be a little bit difficult trying to find the time, at times, to do that.*"

This comment, whilst not necessarily implying a lack of strategic alignment, certainly provides an insight into the NPD process at the organisation. The

conclusion to be drawn from that comment is that their NPD process is similar to the department-stage model discussed in Chapter 2, Section 3. A3 said,

> "*There is* [sic] *the new products that are being driven by orders, and then there's the new products that are being driven by opportunity.*"

From the Design/R&D perspective, Company A doesn't seem to have a NPD strategy, except to respond to customer requests or identified market opportunities.

For company A, the strategic priority appears to be profitability. The drivers for profitability are attention to customer needs. These needs are satisfied by concentrating on lead times, delivery, flexibility, and after-sales service. No clear idea of a business unit strategy was shared by the respondents. It may be that strategic priorities are determined by this organisation, but they may not be communicated throughout the company.

The following responses examine who determines strategy within the organisation. For business unit strategy, A1 said,

> "*It's basically the charge of the four Directors, but more often than not it's the Managing Director and myself that actually make the proposals and in the end, the decisions.*"

A2 said it was the Managing Director. A3 gave a response that was not about strategy, but about meeting customer requirements. His answer:

> "*What determines those priorities is how the customer assesses the contract. So if the customer assesses price alone then that's where we need to put our efforts.*"

The answers to the question on who determines NPD strategy indicate that there is no NPD strategy. New designs are developed to meet customer needs. A1 said,

> "*The customers call the shots.*"

A2 said,

> "*A few things determine it, I think. I mean obviously depending what Sales have organised. And how much time I've been given to do it. I think the majority of the time the customer really determines it.*"

Whist the customer might specify what they want, there are some group processes that decide whether a specific project should go ahead, as evidenced by A3's response.

> "*No, there's Sales/Marketing Director or the General Manager generally see the opportunities. Sometimes they are real and sometimes they are perceived. So what happens is the need or the opportunity is then put to our product development meeting, and we decide then how we go about it. Whether it's a goer or whether it isn't a goer. Make those decisions.*"

Innovation within Company A would appear to be customer led and incremental in scope. This firm fits the customer-dependent type of SME as discussed in Chapter 2, Section 8. Company A operates in a very narrow market, and may face long-term difficulties in growing their business as they become less innovative, and locked into a sub-contractor role for their more powerful customers (Julien, 1998, Lindman, 2002, Raymond and St-Pierre, 2004).

6.4.2 Analysis of Company B Responses

This business unit is the manufacturing arm of a larger organisation. As well as having to mass produce components (internal sales) for the parent, the business unit also designs and develops prototypes for customers. They also develop, build, and sell the machinery and tooling necessary for the customer to mass produce the product that they develop as a prototype. Due to pressure from global competitors, the mass-produced components were being moved offshore for manufacture by the parent company. This meant that the business unit needed to grow its external sales in order to remain viable. It had significant design and development competencies in precision engineering. Its product range included components for cochlear implants and Formula 1 car racing components. Its machinery was state-of-the-art. For their external market, they look to use their capabilities to cater to customers with unique requirements – a niche market strategy.

The business strategy in place at Company B was unanimously one of growth. B1 said,

> "*The strategy is focused on growth, both internal and external.*"

B2 agreed that sustainable growth was the target,

> "*more share of the market, and try and dominate, as such, their product. And that's really the only way you're going to get ahead, but at a competitive rate as well.*"

Growth and profitability were to be achieved, according to B3 through targeting specific market segments.

> "*From a view of competitive strategy is that we need to focus on market segments that are niche markets for our capabilities. So rather than go out to the general engineering market, where we'll be competing with a lot of companies who do a lot of larger projects, just general stuff, we tend to… We have to focus, and we have to focus on the market segments that really are geared up for the precision manufacturing side.*"

Whilst strategy at the business unit level was relatively clear cut, the responses about NPD strategy were less so. B1 referred to the need to work on developing high volume products for external customers, where quality was important. To date, their external sales had been very low volume. Cost tended not to be an issue with customers for these one-off items. They often developed a new product to a customer's specifications, and also designed the production process, and tooling, for sale with the prototype so that their customers could handle their own production. The emphasis had recently shifted to developing products that they could volume-produce in-house for external sale. The shift in business unit strategy required a shift in NPD strategy. B2 believed that NPD strategy could support the business unit strategy by taking advantage of its unique capabilities, to develop products for customers, and at the same time produce them in-house in volume by focusing on efficient design and production. He commented,

> "*Normally, for us, it's something that most people can't do. So we spend a lot of time thinking about how we can do it, and how it can be cost-effective.*"

B3 confirmed the need to concentrate NPD activities on high volume products.

> "*Traditionally, [company name removed] have, from an external perspective, been regarded as a tool room, specialising in sort of one-offs, tooling prototypes. What we're now trying to do with the marketing strategy is to take us into the next, I guess, into another level, where we become a manufacturer of precision components. So I think from the point of new product development, what we're looking to do now is get away from doing… Or still do the one-offs, two-offs, five-offs per month*

type business, but now we're looking at getting into the 10…20…50,000 units per year type business."

The shift in business unit strategy was recent, and it may be that this company has yet to clarify its NPD strategy. Whereas the emphasis in the past may have been on conformance quality and functionality, these may now need to take a back seat to product price and time to market. Though not within the scope of this thesis, the business strategy shift will have serious implications for operations strategy, with the business shifting from a largely job-shop process to mass production processes.

When it came to business unit strategy development, both B1 and B2 were quite clear that for internal manufacture, strategy was determined by head office. In this regard, the business unit was the manufacturing arm of the parent. The business unit was also expected to develop its external customer base. When it came to developing the external business, local management were allowed greater independence. The company had recently employed a National Business Development Manager to work on developing the external part of the business, according to B1. B2 reinforced this dual strategy focus with the following comments;

"*Well, that's determined from the Board and then the people up above. It's a bit of a conflict, because where we are now, we develop… External sales or external work isn't a high priority for our head office because of the system we have here. Our head office is at North Ryde. Their priority is all their steering products and associated products with that, and we still need to support that. So as far as external stuff, it's left up to our company here at Villawood to fight and develop that, and have that as a shining light, as part of the business.*"

This business unit was adopting a growth strategy for its external business. B3, in discussing this strategy said,

"*A lot of the time, the products either come to us from a customer enquiry, or it comes to us from going out and putting our feelers out so the sales department come and bring the product back.*"

As well as relying on the existing customer base for ongoing work, the company appears to be adopting a pro-active approach to growing the business.

6.4.3 Analysis of Company C Responses

This company was the largest SME to contribute to the qualitative portion of the research, having recently acquired a smaller sheet-metal manufacturer. Its core business is sheet metal manufacturing. Its main product range is metal cabinets. The company website claims to be,

> "*Australasia's leading supplier of sheet metal components. We offer customised manufacturing solutions that include design, product development and manufacturing*" (Accessed 2008, company name deleted for confidentiality reasons).

It caters to a broad customer base and has a substantial product range. The company employs the latest technology, and has achieved international quality standard ISO9001.

The emphasis on a business unit strategy was not clear cut for this well-managed organisation. This may have been due to the acquisition of a specialist sheet-metal storage company into the business. This acquisition provided a stable commercial product base for the high-tech sheet-metal business. Managers from the different, but now united businesses evidently had different perspectives on strategic priorities. C1 said,

> "*We're finding at the moment that we're not very competitive, and we're looking at terms to improve the product.*"

Profitability would appear to be the emphasis for C1. C2 on the other hand said,

> "*Growing the Storage Solutions side of the business, and eventually seeing that as being the principal part of our strategy.*"

C3 agreed with this view, stating without too much conviction that,

> *"I think competitive strategies are, at this stage, in expanding the product range or entering new markets."*

When it came to the question of a NPD strategy, C2 provided a comprehensive answer.

> "*The things that we tend to concentrate on is* [sic] *offering a good mix of features and benefits, in terms of value for money… So customisation is one of them. Another thing is, also, looking at all of the various products that are available on the market, and coming up with other innovations or other features that are not being offered by competitors.*

> *So we're doing quite a bit of that. And also in terms of the design flare and design edge. We distinguish out our products apart from the pack by doing things that little bit differently, a little bit more elegantly than what our competitors do.*"

C1 and C3 on the other hand offered no information on NPD strategy, but did refer to a process for deciding which new product projects to pursue. C1 said,

> "*We actually have a form - and it's called prototype proposal strategy - is that we work out, and there's lots of lists of questions that we answer, typically sales, to see if it is ideal to go ahead and actually start to prototype it or sell it.*"

C3 provided additional information on this process,

> "*We've recently put into place a new product strategy proposal sort of forum, in terms of a committee, which involves upper management and also the design team, to strategise and to review and do that sort of thing before taking on a new project.*"

This process can be viewed as an attempt to strategically develop the business in a way that meets the business unit strategies referred to earlier. The NPD strategy seems to be one of product customisation, defined in the quantitative questionnaire as 'adopting existing products to specific customer requirements.'

Strategy in this business unit was driven by senior management. According to C1 a strategic planning process was in place that included all department managers. C3 supported this view, though his knowledge of the strategic planning process was less clear-cut.

> "*Oh, I think it's the management, all the upper management of the company.*"

C2 however believed that business unit strategy was determined solely by the Managing Director.

The NPD strategy seems to be driven by competitive requirements. C1 said,

> "*There's lots of jobs that come in through customers, and then there's some products that we want to develop by ourselves. Probably looking at competitors, to see what they have, and try to follow what they have, as well.*"

C2 also refers to market scanning to identify new product opportunities, but places responsibility for NPD strategy with the Managing Director. C2 said.

> "*He determines specifically what he wants us to develop. But again, it's in consultation with observations that we make in the marketplace. We travel quite extensively. So we canvass trends in overseas markets as well as the local market. And basically identify opportunities where we can fill a potential market need, with things that aren't available from our competitors. That obviously gives us an advantage, and hopefully puts us a little bit further ahead, as well, so it's our competitors playing catch-up, rather than us playing catch-up on them.*"

C3 spoke of "*a team or a committee-based approach*" when determining strategy, but he was referring to the product development procedure referred to earlier.

6.4.4 Interview Observations: Research Question One – Strategic Alignment

For all three business units, it would seem that the business unit strategy is determined by senior management. For companies A and C, the Managing Director appeared to have the power in deciding what the priorities were. When it came to NPD strategy, the customers seemed to be the drivers in Companies A & B. For NPD strategy, Company C had recently implemented a process to pursue products that complemented the organisation's capabilities, and provided it with a customised and profitable product. Company A seemed particularly tied to customer requirements and did not appear to have an NPD strategy other than manufacturing to customer specifications. Company B was moving toward developing products that complemented its capabilities and provided growth opportunities in niche markets. Strategic planning processes were used in all three business units, but strategy did not appear to be widely disseminated. Tacit communication appeared to be the method of conveying strategy. When it came to aligning NPD strategy with business unit strategy, some unique observations could be made. In company A, the customer drove product changes so alignment was not an issue. Opportunities for growth however will be limited whilst the business relies on the existing customer base. For company B, a recent strategic shift has resulted in uncertainty over what the NPD strategy should be. The connection between business strategy and NPD strategy needed to be formalised. In company C, a recent acquisition had resulted in some uncertainty over what the NPD strategy should be employed to support the strategic direction of the business. A new team-based approach to product selection had recently been adopted to correct this

shortcoming. Data from each of the three firms have been summarised for ease of comparison in Table 6.4 below.

Table 6.4: Research Question One Comparison Summary of Interview Findings

Strategic Alignment: Is the business unit's competitive strategy supported by it's NPD strategy			
	Company A	Company B	Company C
Business strategy determined by	Senior management. Not well understood throughout the organisation	Parent company for internal sales. Local management for external sales.	Managing director, supported by snr. Management.
NPD strategy	Driven by Customer needs. Not well understood	Specialist supplier of customer needs in a niche market. Also looking to develop high-volume new products to leverage its capabilities	Driven by competitive requirements. Conflicting comments from respondents
Innovation type	Incremental. Customisation. Cost driven.	Both incremental and radical, using cutting-edge technologies.	Incremental. Customisation.
Strategic Alignment	No explicit approach to alignment of strategy.	Efforts to align NPD strategy with external customers, but impacted on by parent company requirements. No formal mechanisms.	Improving with a team-based approach to product selection.

6.5 Research Question 2 – Management Action Programs

What is the level of management involvement in improving new product development processes and performance?

The second research question to be examined was the extent of management involvement in the organisations new product development process. The literature from which this research question emerged was reviewed in Chapter 2, section 2.4.3 that examined issues relevant to managing and improving the new product development process. In the literature review Prahalad and Hamel (1990, p.91) were cited as stating that "*top management's real responsibility is a strategic*

architecture that guides competence building". As capabilities are developed, core competencies emerge that represent "*the collective learning in the organisation*" (Prahalad and Hamel, 1990, p.82). As well, the CIMA model discussed in chapter two identified behaviours that underpin the capabilities necessary for successful new product development and argued that these behaviours could be influenced by management intervention (Boer et al., 2001). Management interventions or action programs were referred to as 'Levers' in the CIMA (Continuous Improvement and Innovation Management) model. For this thesis an effort was made to examine the types of action programs employed by SMEs to improve their new product development process. With the quantitative component of this thesis, organisations were asked to provide data on the degree of effort placed on various action programs, the perceived value of various action programs, and the types of action programs they might pursue in the future. An analysis of the findings was presented in Chapter 5, section 5.3. Action programs were also examined in the qualitative interviews and are discussed in subsequent sections.

A second significant contributor to competence building and collective learning that was identified in the literature was teamwork. A cross-functional team-based approach in developing new products accelerated new product development (Imai et al., 1985). Teamwork also supported knowledge generation and learning (Lynn, 1998). For this reason, questions concerning team-based action programs were included in the qualitative survey. In the quantitative data analysis chapter, the relative usage of various action programs was examined. With the qualitative interviews, the research hoped to identify the drivers or inhibitors for those action programs. As with the first research question, the qualitative responses are examined on a company-by-company basis.

6.5.1 Analysis of Company A Responses

In the quantitative survey analysis the data showed that respondent firms exhibited a low level of team-based activities relative to the high levels of such activities identified in larger organisations. For company A, this also seemed to be the case. Senior personnel from the different functional areas met weekly to go over

production plans for new orders for non-standard items, though at the time of the interview these were not occurring. As A1 said,

> "*we do have a meeting …. but the guys are so busy we've suspended it. Because they're actually working on projects.*"

A2's response was indicative of a lack of team planning for new products. His words describe an informal process where sales or engineering personnel will interrupt him for input on the feasibility of a particular project.

> "*It mainly starts with that. Which can get a little headachy sometimes for me to handle. Trying to handle when you've got a few going at once. But that's basically it. Procedurally, it should go along the lines of, 'What is the change?'. Sales communicating with Engineering. Engineering designing, drawing, building material, all that. And then it comes through to me and then I do a build.*"

The haphazard approach to planning new product projects was confirmed by A3. His response indicated that meetings were largely about scheduling, with inputs from various personnel on the feasibility of a particular new product design.

A range of questions were asked about the action programs employed in Company A to improve NPD performance. For respondent A1 was unclear about action programs aimed specifically at improving NPD performance. He did refer to regular weekly meetings, but those were largely to do with production planning. The company was involved in a formal continuous improvement program using constraints theory, but again this was directed at process improvement more so than NPD activity. With regard to pursuing different action programs in future, the response was negative, on the basis that there was substantial room for improvement using existing programs.

> *"Oh, basically no. There's enough to do with what we've got to do even better. Typical idea is, we don't have a particular contract with one of the big companies. Why not? Our product is too expensive. So the project then is to win the business and then make it more cheap. You can't do it the other way around, right, because you can focus your assets on things you're never going to get. So you take a deep breath, go for a price you know will win it, or you're prepared to go for, to win it, and then you put all the resources that we've got into achieving a profit out of that particular job".*

A2 referred to an increasing number of new products being manufactured within the company. In the past they were principally customer driven, though a more proactive stance to NPD seemed to be emerging.

> "*Well over the past, there's been a lot of customer changes, but in the last couple of years we have been concentrating a lot more on new products too. There has been a lot of new product development. We have been trying to get into a new market. So, a lot of it's been for tenders and samples and stuff like that*".

A2 referred to new CAD tools,

> "*Definitely the CAD. We've got a 3D package which was, I mean, you've probably spoken to the boys already about that. Yes that was, as far as I understand, part of the reason for getting that was so we could design this new three dimensional… and try it out on the computer before we even....*"

When A3 was asked the questions relating to action programs his response was,

> "*The truth of the matter is, most of the things we get into, are jobs that just need doing. They don't need too much control because the customer's told us what they wan*t".

When shown a list of different types of action programs as listed in Q2.10 of the quantitative survey he replied,

> "*We don't have formal action programmes that fall into these categories*".

When asked about continuous improvement programs the response was,

> "*It's very informal at the moment. It's covered by the product development meeting. Normally improvements are identified by things taking too long in the workshop, things costing too much. So we have this "squeaky wheel gets the oil" approach*".

When asked about whether their action programs were evaluated A1 was somewhat vague.

> "*The guys who are doing it know if it's going in the right direction or not. And you begin to see, particularly the assets improve, or the amount of time somebody's got then allows him to do other things. So it's done, but more by, you see it happening. And people watch all of the time. You introduce nothing here that nobody doesn't measure by some method*."[sic]

A2 replied along similar lines.

> "*I don't know how formal it is, but definitely yes.*"

A3's response was a definite "*No*." to the question of evaluating action programs.

For Company A, teams are built along functional lines. Instructions relating to new jobs should be conveyed at senior team meetings, but more often than not are passed along from sales to production. Team meetings are subservient to production imperatives and may be cancelled when the factory is busy. The business seemed to be concentrating its action programs on productive efficiency rather than improving NPD performance. NPD activity seemed to be very much customer driven. There seemed to be no well-understood measures for evaluating NPD performance.

6.5.2 Analysis of Company B Responses

The importance of teamwork seemed to be an emerging concept in Company B. As B1 said

> "A*s we're going through a structural change now, I think [name deleted], in particular is learning very quickly of the importance of a team and a structure with that team*"

Cross-functional teams do not appear to have been developed as yet. B1 said,

> "*Well, the teams are traditionally the three separate teams or business units, which was the forge, the micron and the production*".

When asked about the composition of new product teams, this respondent was unclear on their makeup and when offered suggestions as to various functional personnel being involved would only reply "*Possibly.*" B2's response was interesting in that it was apparently contradictory. His response to Q15 in the qualitative survey on the importance of team-based improvement efforts was,

> "*Well, we don't… at the moment… we used to have a strong team base set up. And with us looking at different avenues, and becoming slightly more focused on external rather than internal, people have swapped over from teams, so it's becoming project-driven rather than team-driven, and it's becoming, 'That guy there is a part of that project till Wednesday', and then he's available to go on another project. So really, if you're going to say teams are evolving and changing the whole time*."

In effect, the project teams referred to are cross-functional new product development teams. Perhaps this manager perceives teams along more functional lines. Uncertainty of the team concept was confirmed by B3's initial response to the question.

> "*Very high importance. If by team-based, then maybe you can explain what… To make sure that I'm thinking in the right direction?*"

Subsequent clarification listed a number of functional roles indicative of cross-functional teams.

For this organisation, a change in competitive environment had forced management to look for new business opportunities. This in turn had led them embrace new types of teams – cross-functional and project teams - as opposed to teams based on functional activities. The managers interviewed had yet to come to grips with the complexities of cross-functional teams. For instance, B2 had commented that team makeup revolved around combining suitable 'personalities.

> "*Personalities is* [sic] *a huge part. You know, there's two people you couldn't put on a team, because you know it would stalemate, and you might have a personality clash. So you try and keep them project-based, separate, and a few other things. And it's knowing what skills are available to bring to the team at that point of time.*"

There seemed to be limited attention paid to action programs designed to improve new product development performance (Qualitative question 11). Following on from the comments in the previous paragraph about a project based approach to teamwork, B1 did comment,

> "*Project management, I think, has been a bit of an issue.*"

B2 made a number of observations. He saw the company's quality system as driving action programs. Quality however was tied to the value of a particular project.

> "*We have our quality system. Our quality system asks us to rank, in three categories, what the project or the job is. And it's a Level A, B or C. And these are ranked between difficulty and dollar value*."

The company used sophisticated CAD/CAM programs so developing such tools would not be thought of in terms of an action program. As B2 said,

> "*Nearly everything we do is CAD/CAM. So we just take it as normal that it's going to be on there. It's nothing new to us, it's not like, "Oh, we have to put it on CAD/CAM." For us, that's just natural. So we don't even think about that as being a tool*."

B3 seemed to think that CAD/CAM was very much an action program designed to improve NPD performance. His response to question 11 was,

> "*We're talking about now getting in some new software for our design engineers. We're looking at getting new equipment. We're upgrading our CMM, our [metrology] department with our measuring capabilities. And all of those, I guess all those areas, if you look at new software for our design engineers, so that our design capability is upgraded… New equipment for some of these new product developments that I've mentioned, where we're looking at getting very large projects, very large volumes, that we don't have the capability at the moment.*"

Based on these responses, there seemed a lack of a unified understanding of what was being done to improve NPD performance. This may be indicative of the absence of a strategic approach to new product development.

Conflicting evidence came from the three respondents on the management of NPD action programs. B1 stated that current and future emphasis would be placed on project management activities as an action program. When asked what might lead to a shift in future action programs he commented,

> "*If the firm wants to pursue different improvement programs, then obviously one would think they're possibly not happy with the current staff they have, and want to improve the staff as well. So a program could be, you know, sourcing employment*."

His response to question 14 on how the organisation evaluates its action programs was,

> "*I don't really think we do*."

How this organisation can conclude that personnel might be the source of poor performance when action programs are not evaluated is difficult to understand. B2 referred to the need to work more closely with suppliers in future. When asked about factors that might choose to pursue different improvement programs in future he commented,

> "*We should have a closure meeting, a meeting that comes back and talks about the problems. Because you can only learn by your mistakes, so we should come back and look at the problems. So, by doing that, you*

can flag up, then this can be added to the start, and then from that point on, we can ask these certain questions or look at a few things."

This is indicative of a reactive approach to NPD improvement. Measuring the value of action programs also seemed to present difficulties with B2's response being,

"*Well, I don't believe they're evaluated.*"

B3's response to future action programs revolved around growing the business rather than improving NPD performance. When asked what influenced their NPD activities his response was,

"*With us, it's normally competition. From overseas ... So I guess that's one of the major influences, I guess, on our strategy, is that as we work with the customer and develop their product, the requirements change, and we have to change with them.*"

Though not stated explicitly by this respondent, future action programs would seem to include customer participation in NPD. B3's response confirmed those of his colleagues as to the lack of evaluation of action programs.

"*I guess that's where we're a little bit probably… we're lacking, I guess, and we're learning. And I guess, again, it all comes to, historically, [company name deleted] have never had those methods of evaluation in place, because they haven't really had to measure it.*"

For this company a team based approach to developing new products appeared to be in its infancy, and this may impede the growth of competencies in developing new products. There seemed to be no strategic approach towards improving their NPD processes, Activities that might improve NPD performance were not being evaluated. Though the company had well developed manufacturing processes and high levels of quality, NPD activity seemed to be customer driven and lacking a proactive approach. This might be a consequence of being the manufacturing arm of a larger organisation. With greater emphasis being placed on the need to develop a broader external customer base, the company needs to be more proactive in building customer relationships, marketing its capabilities and working with customers to develop new products.

6.5.3 Analysis of Company C Responses

Teamwork within this business unit also seemed to be concentrated on functional activities. C1's responses were to the teamwork questions revolved solely around activities of the Sales team. She saw her role as communicating with and motivating her team members in order to improve their performance.

> "*Sometimes you find that someone doesn't perform as good if you don't actually talk to them, and a lot of the time, they don't speak out in a group. So I believe, like, talking to them, and making sure that they're happy within their role and what they do, I think that's very important*."

Apparently, even within functional groups, some team members are unable to express themselves. This manager felt uncomfortable when asked about areas beyond her immediate functional responsibility. The ability of the Sales department to contribute to new product development seems problematic. The Operations Manager, C2 was more forthcoming in discussing cross-functional NPD teams.

> "*Oh, it tends to be a real mixed bag. There's… I'll give you an example. We just developed a product from a customer's photographs. He had some pictures of a product that they wanted. We had some rough overall dimensions. So, you know, obviously the sales engineer that was involved in that was part of the team. There was the designers. There was myself, I was personally involved in that particular one. People on the shop floor were involved, in terms of putting it together, and identifying any deficiencies in the design that we had to tweak and change. So yeah, it was a complete… it was like a mini team, with representatives from virtually every discipline in the company. With the exception of Accounts!*"

There is evidence here of an organisation possessed of competencies on which a customer can depend. The team described as a 'mini-team' is a NPD project team and is clearly cross-functional. C3, the design engineer also adopted a functional leaning (as did C1) in his responses. When it came to specific projects however, he indicated that teams would be formed on a needs basis and include representatives from the various departments.

> "*It would be the departments involved.*"

This company is well managed and controlled along traditional functional and hierarchical lines. The company does have competencies that it can bring to bear when faced with new challenges and opportunities. These seem to be customer

driven. There appears to be lack of internal cross-functional communication that may inhibit the emergence of genuine business opportunities and therefore restrict innovation within the firm.

With regard to action programs employed, C1 indicated that those were the domain of design and operations, and not sales.

> "*Oh, again, I believe it's a lot of Design and Operations. I don't think we've really got an action plan in place.*"

There seemed to be no understanding of the role of sales and the customer interface in providing inputs into the development of new products. This may be in part due to the senior engineering and design managers having direct contact with customers, thus bypassing the sales area when it came to technical matters. When given a list of the various action programs, C1 acknowledged that the great bulk of them were actually used within the organisation, but not in the capacity of improving the NPD activities of the firm. As mentioned in section 6.4.4, this company had recently acquired a smaller sheet-metal manufacturer and was in the process of assimilating its product range. This had involved internal restructuring, including a design function that could possibly result in new NPD action programs being implemented.

> "*We've just had the senior design over say, six to eight months to a year's time. So a lot of this, I'd say, would be implemented within time.*"

The Sales department seemed to be more administrative than innovative. This seemed to be at odds with the responses from C2 that indicated a substantial role for Sales and Marketing.

> "*Well, we do have customer participation in our new product development. Largely, a lot of the ideas are generated by the customers. So we sort of use those as a basis of the design input that goes into, you know, the development of the products. And the participation of Marketing and Sales in new product development, that's another one. Production does participate, but more in the final stages, in terms of determining practically, how something can be produced.*"

The importance of Sales and Marketing were further emphasised when it came to developing products for which no market currently existed.

> "*If we had a situation where there was no existing market for something, we were basically developing product on the basis of something that was never available before. Then, yes, I suppose you would have to go for*

different techniques. It would be a lot more sales and marketing focused. We would probably have to do a lot more research into what the customer's potential needs might be."

C2 also said,

> "*At the end of the day, probably the customer participation is the most important one, because ultimately, that's the need that we're trying to fulfil, and in particular, if it's a customised product, it's specifically tailored to their particular taste, they're the most important participant in the program.*"

Given that C2 saw customers as the key drivers of innovation activity within the firm, there seems to be a clear need to develop capabilities within the Sales and marketing function that will support NPD activities. C3 advised that technology upgrades in computer aided design tools had recently been undertaken to improve NPD performance.

> "*Just before I was with the company, they took on board the CAD system, a 3-D modelling CAD system. They employed that in, like, its full capacity, which was an investment to improve the accuracy and the efficiency of the design process.*"

Both C1's and C3's responses were narrower than C2's and confined to their functional roles. Generally, action programs aimed at improving NPD performance were not well understood, indicating a lack of strategic focus on NPD, a lack of communication about NPD action programs, or both. Action programs appeared to be developed in response to a range of drivers including customer or productivity needs, and strategic requirements. C2 said,

> "*It tends to be like either a specific customer requirement, or in terms of our overall strategy, it's our own timing on what we feel is an appropriate time scale for getting these developments done.*"

C3's response to the question of the forces that drive action programs was,

> "*I'm sure there were a lot of reasons. But one of them was to definitely stay up-to-date in technology, so in terms of this organisation's outlook. And longevity, based on heavy investment in technology, and being up-to-date with current trends. But also, on the other hand it was probably about, again, improving efficiency."*

When asked whether the organisation evaluated the performance of its action programs, the conclusion would have to be that they are not evaluated. C1 replied,

> "*I can't say that we do*."

C2's response was

> "*It's a bit difficult to measure. Just bear in mind that we've only been at it for a little while now, so we're probably not as mature as what we'd like to be.*"

C3's response was

> "*No, not… not that I'm aware of.*"

As with Company A and B, this organisation seemed to have well developed functional processes, but limited cross-functional team based processes, at least in terms of new product development activities. Action programs did not appear to be specifically designed to improve NPD activities, though they did contribute to the development of competencies that could support new product development. The effectiveness of various action programs did not appear to be evaluated, but were taken up on a needs basis.

6.5.4 Interview Observations: Research Question Two – Management Action Programs

The questions concerning action programs within SMEs sough to evaluate their use in developing competencies that supported the NPD process. Also examined within this group of questions was the extent of team-based activity in NPD.

It was evident from the responses that these organisations do pursue various action programs, but none are specifically implemented to improve their NPD processes. Instead their action programs concentrated on improving operational efficiencies that would generate a competitive advantage. In this regard the action programs do contribute to the development of competencies that customers' value. This could lead to orders for new work that falls within the definition of a new product (see Table 2.1). The actual manufacture of new products is a very narrow subset of the activities that constitute the new product development process, as explained in paragraph 2, section 3. Under such conditions, the issue of customer dependency becomes a concern. Even where action programs might lead to an enhanced competency in developing new products, the action programs were not evaluated from that perspective.

Team-based activity was inconsistent amongst these firms. Certainly cross-functional teams that are necessary for new product development seemed to be lacking, or in the very early stages of development. All the firms had clearly defined functional teams. Communication appeared to be an issue with cross-functional teams in Company C. In company A, the demands of meeting production schedules seemed to get in the way of team meetings. In Company B, there was recognition of the need to improve teamwork, and cross functional teams were in evidence in their project approach to new work. Data from each of the three firms have been summarised for ease of comparison in Table 6.5 below.

Table 6.5: Research Question Two Comparison Summary of Interview Findings

Management Action Programs: What is the level of management involvement in improving new product development processes and performance?			
	Company A	Company B	Company C
Action Programs	Uncertainty amongst respondents as to what was being done. Not evaluated.	Some but not targeted on NPD activities. Not evaluated.	Not well understood. Driven by customer requirements. Not evaluated
Teamwork	Haphazard. Personnel work along functional lines.	An emerging concept. Project based teams.	Principally along functional lines. Evidence of cross-functional project teams.
Future direction	Unclear. No formal action programs.	Conflicting evidence from respondents.	Possibly to develop NPD capabilities in the sales and marketing function
Management involvement	Very limited. Principally concerned with productive efficiency.	No evidence of a proactive approach to improve NPD performance.	Passive and reacting to customer or productivity needs

6.6 Research Question Three - Management of NPD Projects

How should SMEs manage their new product development projects?

Research question three sought to further examine the management of the NPD process within SMEs. The previous research question looked at the level of management involvement in NPD processes from the perspective of improving those processes via action programs. With research question three, this research examines how well developed the NPD processes are in SMEs, and whether the maturity of their NPD processes supports innovation within the firm. Well-developed in this context refers to the degree of formality and structure. Well-developed processes should be systematic, with clearly defined stages and activities (Cooper, 1994). In chapter 2, section 3, literature dealing with various NPD models was reviewed. In section 2.6 the literature review established that, within large organisations, a systematic approach to developing new products would generally lead to better outcomes (Cooper, 1994, Cooper and Kleinschmidt, 1986). Research question three sought to determine whether this relationship would also hold for SMEs.

When analysing the quantitative data relevant to this research question in chapter five several conclusions were drawn from the data. First, that innovativeness of the respondent firms does not appear to be affected by the approach taken to the management of NPD projects, whether this approach is informal or systematic (5.4.1). When the performance of the respondent firms was evaluated against their NPD process across two dimensions, reputation and time-to-market, different outcomes were found. In terms of the firm's reputation, it appeared to be independent of project management procedures. However, the way in which NPD projects were managed did appear to have a significant impact on reducing the average time-to-market for new products (5.4.4). In the following sections the more detailed responses of employees who participated in the in-depth interviews are analysed. Unlike the quantitative analysis however, the outcome examined in the qualitative interviews was whether the organisation's NPD process was supportive of innovation. The open-ended responses were too general to identify specific

performance dimensions that may have been influenced by the NPD process employed within the organisation.

6.6.1 Analysis of Company A Responses

A1 believed that his firm had well defined and formal procedures to be followed when it came to evaluating and managing NPD projects.

> "*It's formal. The process is the same, no matter who comes up with it. It will get looked at by this, the aforementioned team, and go into the system based on the various judgement or judgements of the committee or the over-ruling strength of whoever wants the thing done. But it's pretty… It's not democratic, it's pragmatic*."

So the process is formal at least, but the decision on whether or not to proceed with a given project is more subjective. A1 hinted at situations where changes could be made in parts of the system without the proper procedures being followed.

> "*It happens sometimes by accident. We're trying to upgrade the systems of control, and sometimes we leave a gap that things fall through. But it's not supposed to happen. It's not designed to happen. We have formal methods of introducing all of the new designs to manufacturing to supply as to everything else. And part of the IT upgrade was to make that more electronic than paper*."

When asked whether their approach to managing new product development supports or hinders innovation A1 responded,

> "*Oh, it supports it, because it's controlled. You know, there's not people running around with wild and strange ideas complaining they're not getting done. We've all agreed what we're going to do, and the products come out. … we've taken a number of contracts on that we wouldn't have won with previous pricing arrangements, and reduced the cost … it shows on the bottom line … you go into the system and show where these developments have proven to be successful*."

By contrast A2 thought the company's NPD program was informal.

> "*I would say it's more been on the informal side. Definitely, definitely informal. I've always been pretty organised though. So, I don't know how, that opinionated it is. But, I think it's been informal*."

When asked whether their NPD approach was supportive of innovation, A2 replied,

> "*I think it definitely supports it, yes*."

Whilst subjective opinions differ of the 'formality' of the process, both at least agree that it supports innovation within the firm. A3 saw their NPD process as having,

> *"a foot in each camp. We've got a foot in the formal camp and the ad hoc camp. We are formal by the fact that we have meetings. We minute these meetings. We decide what we are going to do and where we are going to go with those meetings. We are informal; we stop at the point of having a projective definition and appointing a manager, and the sort of things which don't seem to happen. And I think there are good reasons for that. The first reason is the jobs are usually too small to warrant it. It's like cracking a peanut shell with a sledgehammer, so to speak. But, we have big jobs where we could have benefited from that approach and we didn't put it in.*"

It makes sense that different approaches to managing NPD projects should be influenced by the scope of the project. A3 also agreed with his colleagues that their NPD processes supported innovation within the firm.

> "*I think it supports innovation because people get to have a say*."

When the respondents were asked what the firm could do to improve the new product development process, a variety of responses were forthcoming. For A1 it was about building capacity across the board by investing in assets.

> "*We'd need more assets. It's difficult to pick where. You'd need to reproduce what we've got everywhere. We'd have to have more design. More sales and marketing. More factory. More of everything. There isn't one particular area you could like pour money in, or anything else, that would make a difference. You'd have to lift the whole organisation. And that could, or will, happen, like a spiral*."

A2 referred to the need to work on their product mix.

> "*We are looking for a more constant cash flow, I guess. Because a lot of the work we do, or we were doing was very long lead time stuff and a lot of design, a lot of specification, liaising with customers and all that kind of stuff. And we have been looking for a product that's more regular turnover*."

A2 also referred to the need to concentrate on front end activities.

> "*I was talking about a few and what I'd like to see as far as checking it's going to work... Usually we do. but it's informal and it's kind of last-minute.*"

A3 was strong in the belief that the organisation needed to convey lessons learnt throughout the organisation.

> "*What the organisation is very bad at, is disseminating things we learn in one area through to other areas. That's an area we could lift our game. I'm not sure how we would do it. But things learnt by one group of people on a project are not fed through to other people working on other projects. And that could be valuable.*"

That is certainly a view that is supported in the literature (Bartezzaghi et al., 1997, Caffyn, 1997).

For Company A there appears to be subjective differences on whether their NPD process is systematic or informal, but A3 neatly provides a reason for this disparity, that being the differing complexity of the various projects. All seem to agree that the company's approach to developing new products is supportive of innovation. Opinions on what could be done to improve their NPD process differ significantly. There is scope here for the company to strategically manage its NPD processes in order to arrive at a unified approach to improving them.

6.6.2 Analysis of Company B Responses

B1 could not, or would not provide an answer on the innovation process within the organisation. Rather than describe it in terms of formal, systematic, or informal, he instead described it as being 'responsive' to the needs of the parent organisation in terms of developing solutions, but 'hesitant and cautious' when it came to external opportunities.

> "*For our own, I think we're pretty responsive. I think we're very hesitant and cautious for external, and probably rightly so.*"

When questioned about the effectiveness of their NPD process in supporting innovation, the response was also ambivalent.

> "*I don't think it hinders it. I think it drags it out. I mean, but then again, someone comes up and they want a new product, and okay, we're an innovative company, and yes, we can do it, we're not just going to go and pour hundreds and thousands of dollars into something that may never, ever happen. So I can understand that dragging out a little bit, but… I don't think they hinder.*"

B2's response to the question on NPD process formality provided a useful insight into B1's uncertainty.

> "*I'd say probably six months ago, it would have been very informal, and we're building up to a stage now where it's somewhere in the middle. I mean, I still think there's lots of other little things to do. And you'll only know that by going through the motions every time, and then coming back and saying, "Okay, well, how about we add this in here, or we do this, or we create that as a standard document, or a few things that will help)"… Now, I can see us moving forward in that direction. I just don't think we're at that level yet*."

Their NPD process is in a state of transition from informal to formal, possibly driven by the need to expand the volume of what they call 'external' work. In the past, R&D had been carried out by the parent company and Company B worked on manufacturing the product, so the emphasis for them was on process innovation. Changing economic conditions were forcing Company B to look for external opportunities. When asked whether their approach to developing new products supported or hindered innovativeness, B2 replied:

> "*Well, I don't think it hinders. I don't think it hinders. For example, if a product comes to me, then I'll just go sit back and do what I have to do. And I'll come back and say, "There it is there, sell that to the customer." So everything is reliant on me, it's a one-stop shop. So really, the only hindrance is, is if someone comes up and bothers me, I suppose*."

This remark supports the observation made in paragraph 6.5.2 above that cross-functional teams do not appear to have been developed in Company B. Perhaps more concerning is the perception of both B1 and B2 that their existing processes do not hinder innovativeness. By contrast B3 was emphatic that their NPD processes were very formal.

> "*Okay, on the internal business. Oh, actually, internal/external systematic. Definitely, very much so. We'll look at an opportunity. We'll have to look at what's involved, what equipment, what resources are required. We'll do a risk assessment. And we'll look very, very… I guess to the finest detail of how we would manufacture… We make sure we capture all costs as part of the process to manufacture a product. So yes, very, very systematic. Never informal. Because of the type of business we do, we have to make sure that we really conform to customer's requirements, specifications and you can imagine when we're talking about components that are implantable in human beings that there's no margin for error. Everything has to be followed systematically, yep*."

B3 appeared to be on the same wavelength as the others when asked whether their NPD process supported or hindered innovativeness.

> "*That's a difficult one, really. I don't think it hinders so much. It seems to be all part of the process, you know, we look at the requirements. And as I say, especially when we look at the biomedical or telecommunications or, and any products that need to be implantable or they need to be put together in a clean room type environment, we look at the process required. And then, because it's systematic, one of the steps in that process would be to say, "Okay, how can we be innovative? How can we change the way this has been done in the past? What can we look at? Can we look at new ways of dealing with the material? New ways of manufacturing? New ways of, perhaps, distribution? New ways of delivering?" So a part of the systematic process in our case would actually be helpful to the innovative side, yeah.*"

When asked what could be done to improve their NPD process B1 replied,

> "*I think, to improve their product development, to be more open, to be more open with their staff. For instance, the new* [specific material deleted]. *There's no feedback on how it's all going. No one knows how it's going here. We've spent months building all the tooling and the bolsters and the machines, and then we ship them all over, and then we jumped on planes, and spent three months away from our families. And now it's… who knows? So they would be a lot better off if they communicated more with their own staff, so then their staff feels more of a team to – you know what I mean? – be more pro-active and have more energy in what the company's trying to achieve or do. Instead of only being told on a need-to basis. Does that make sense?"*

The absence of teamwork is reinforced by poor communication and feedback. B2 commented,

> "*Well, I haven't got any real answers for it. Back to what I was saying, I don't believe we're striving for that stage. And for what we've done up until that has been satisfactory, okay. It's worked. But only on a personal scale. But when you start talking…oh, being a little bit bigger, being multiple parts, you know, and having more work flow through, I think it needs to be developed. I think there's a development plan that needs to be in place. And probably any information we can get from outside would help."*

Evidently giving attention to their NPD activities is not a priority at this time. B2 recognises however that the shifting emphasis to external work might require the company to look critically at its NPD processes. B3's response was,

> "*Where do we start! I guess really, it's just to maybe tighten up a little bit on our current processes, where perhaps we, as I mentioned before, we have our launch meeting, and we have our review meetings, but*

perhaps maybe in-between we could tighten up our process where we perhaps monitor more closely. Perhaps our reporting could be a little bit better in between the meeting. So you know, we do it right, we start off, we review, and then we sometimes have a close-up meeting. But I think sometimes in between we're not capturing as much information as we could."

This hints at the need to better evaluate their NPD projects, to capture that information and learn from it in order to improve future performance.

For Company B there appear to be significant differences in opinion between the respondents on whether their NPD process is informal or formal. There was no strong support for the effectiveness of their NPD process in supporting innovativeness. Indeed all three respondents were somewhat negative in stating that they did not feel the process was a hindrance, rather than providing a positive comment. The comments on what could be done to improve their NPD process revolved around improving communication, and evaluating the performance of their existing activities. Both demonstrate a lack of understanding of the NPD process which would, one expects, adversely affect their NPD performance.

6.6.3 Analysis of Company C Responses

C1 believes that new product development is something relatively new to the firm. When asked to describe their NPD process on a continuous scale from informal to very systematic, the response was,

"*In the middle. It's more systematic than informal. Probably in the middle."*

C1 was also unsure of the benefits of their approach in supporting innovativeness within the firm. When asked whether the process hindered innovativeness the reply was,

"*No, I don't think so*" and whether it supported innovativeness, "*Yeah. I believe so"*.

From C1's perspective quite a deal of uncertainty existed. C2 was somewhat more expansive stating,

"*It's probably somewhere in between. I like to call our process evolutionary, because what we're tending to do is, okay, well, we've put*

some formal processes in place, mainly due to our ISO accreditation, you have to have those formal things in place. But it doesn't mean that that's the best way of doing it. And as we're going along and identifying, it could be a shortcoming, or a possibility for improvement, or whatever. That feeds back in, and we're gradually improving our formal processes. So we try not to be too rigid in our approach, so we do provide some level of flexibility so we can sort of capitalise on an opportunity that might come along."

When asked whether their NPD process supported innovativeness the response was,

"*Hopefully support! I mean, you have to have a systematic approach; otherwise you make too many errors. And yeah, and also, the systematic way also allows you to continually improve what you're doing*."

C3 made reference to an increasing formalisation of their NPD process.

"*We are now pushing formal. We are now become… yeah, we're definitely not informal. I think we've moved beyond that, and we're starting to become procedural and formal about it.*"

As to whether their NPD process was supportive of innovation, C3 was uncertain.

"*Oh, I don't know if I could say either way at this stage. I don't see it as a hindrance, but I don't know if it's actually going to improve the innovative and either the innovations or the things that we consider to be innovative. Yeah. I wouldn't know how to answer that one at this point.*"

On the question of what could be done to improve their NPD process, C1 replied,

"*What could we do to improve it? If you asked me probably two months ago, I would have said, definitely a project manager, which we've just put on, to be able to draw that information together which we did not have. That's a step in the right direction at the moment. Probably more marketing at the moment, to identify what's out there, so we can find out what we're missing out on, and what we're actually capturing. That would be handy to know*."

Not surprising to have a market related response from the Sales and Marketing function. C2 said,

"*I suppose the principal thing that springs to mind is to have this bent on continuous improvement and continually learning, and improving what we're doing. That's really what it's about. As I said, the process can't be rigid and fixed. There's always improvements that can be made. It's being able to identify what those things are, and feed that back through*."

This desire to improve via feedback and learning resonates with A3's response in section 6.6.1, and B3's response in section 6.6.2, above. C3 provided a lengthy answer that also pointed to the need to learn from past projects. His response also indicated a need to measure outcomes, and take better advantage of existing capabilities.

> "*I think I would like to see the organisation maybe undertake or get involved in concurrent type design and development, to try and improve efficiency, so we could segment tasks and things, in terms of the design responsibilities. Because currently, like I said, we tend to work on an individual project to person type basis. And I can see some merits of doing… We've got the software, for example, in the CAD package, to facilitate concurrent design activity and that sort of thing. But I don't think we're employing that very well. I think you probably need to get more systematic, like, back to one of the other questions. Keep going in trying to formalise our processes and procedures to ensure that one, we are following a set-down system, and two, that we can then collect data or collect information that will then, at the end of a project, quantify where our strengths and weaknesses are. So that we can try and improve them for next time around.*"

For Company C there is evidence of an increasing shift towards a more formal NPD process, but a deal of uncertainty as to the effectiveness of this process in supporting innovativeness within the firm. This may be due to an inability to measure process outcomes. When asked what could be done to improve their new product development process all three respondents gave reference to the value of information. C1 saw it as a valuable input into the process, whereas C2 and C3 saw it as providing feedback for ongoing improvement.

6.6.4 Interview Observations: Research Question Three – Management NPD Projects

The literature discussed in chapter two provided support for the position that the better performing large organisations tended to have well-developed and structured innovation management processes. Whether the same can be said for SMEs was under investigation with research question three.

Respondents from all three companies were divided on their assessment of the systematic nature of their NPD process. Company A respondents indicated that a contingency approach to managing their projects is adopted, with more formal

processes being applied to more substantial projects. Company B respondents all spoke of the need to formalise their NPD process. Even B3 who was firm in the view that their process was systematic and formal said there was a need to "tighten up" their current process and monitor it more closely. The NPD process in Company C was described as moving towards one that was more systematic. They viewed information as an important contributor to a more effective NPD process. Various respondents from all organisations spoke of the need to evaluate their NPD activities which leads nicely into the final research question. Data from each of the three firms have been summarised for ease of comparison in Table 6.6 below.

Table 6.6: Research Question Three Comparison Summary of Interview Findings

Management of NPD Projects: How should SMEs manage their new product development projects?			
	Company A	Company B	Company C
NPD Process	Varied according to the scope of the project. Typically informal	Informal, but being looked at, with a view to implementing more formal processes.	NPD considered as something new to the firm. Evolutionary and moving towards a more formal system.
Link to Innovation performance	Supportive.	Not a hindrance, but sot considered supportive	Principally along functional lines. Evidence of cross-functional project teams.
Approaches to improving NPD process	Build capabilities. Balance cash flow. Disseminate lessons learnt	Better communication needed. Greater involvement and teamwork, Need to improve project evaluation	Provide feedback on lessons learnt. Need to measure process outcomes.

6.7 Research Question Four – Measuring NPD Performance

Do SMEs measure NPD performance, and does such measurement influence strategy?

Research question four involved an investigation of new product development performance and how it is measured in SMEs. Also under investigation was whether

measurement of NPD activities provided a feedback loop into the business units NPD strategy. The literature relevant to this research question was reviewed in Chapter 3. The importance of performance was established, and the various functions of performance measurement were discussed (Bonsdorff and Andersin, 1995, Park et al., 1996). The literature review paid particular emphasis to performance measurement for product innovation (section 3.5), though it was evident that very little research into measuring new product development performance in SMEs had been undertaken. This research was undertaken, in part, to examine NPD performance measurement practices in SMEs, with a view to determining what is measured, and how the data collected from measurement are used.

Research question one has already touched on performance measurement by exploring the extent to which the relationship between business unit strategy and NPD strategy might impact on performance. In Table 5.5, respondents to the quantitative survey were asked to provide their subjective opinion on how business performance across a range of dimensions had varied relative to three years prior. These subjective opinions do not necessarily mean that quantitative measures of performance were collected and analysed. An analysis of the qualitative data relevant to research question three (section 6.6 above) had shown that some respondents had identified a need to better measure NPD performance (respondents A3, C2, and C3). In the following sections, the qualitative responses relevant to performance measurement in SMEs are analysed, in order to provide further insight into NPD performance measurement practices in SMEs. The questions on NPD performance measurement were asked in two blocks. Questions 8 through 10 dealt with what was measured and by whom. Questions18 through 21 asked respondents to evaluate the usefulness and effectiveness of their performance measures, and whether they influenced the strategic direction of the organisation.

6.7.1 Analysis of Company A Responses

The Sales and Marketing Manager (A1) in Company A indicated that the principal measure of NPD performance was cost, compared to design estimates. This activity was carried out by the senior designer who both monitored and measured job costs.

> "*We have a costing system now, that picks up the costs of all of these things. Everything that's made. But Bob's job, part of his job is to look through the costs of things that are made and try and have them either re-designed, if he thinks they need it, or use a different technique*".

A2 (Production Planner) however was not aware of any measurement activity that focused on their new product development practices.

> "*Not to my knowledge. I don't know if anybody else does it but… not to my knowledge.*"

A3 believed that the only measure of NPD performance was whether or not the job was profitable.

> "*The success is that we do it, it worked, and there's money in the kitty at the end of the year. Broadly they are the measures.*"

This respondent's reply to the question of who measures performance was both interesting, and amusing.

> "*The success or failure is recorded by the customer complaints. In other words, if we don't get a complaint about it, we assume that everything went fine. And everything's working. Our customers are very vocal in their complaints.*"

A1's response to what measures he considered most useful was,

> "*Well, it would be return on investment. You know, how much have we spent to get this damn thing rolling? And again, overall profit. Basically, we go for the ones with the dollar signs on first. By the time we've addressed those, there's very little else we need to, we have time to chase. Perhaps I should have said, we do obviously look at the customer's reactions.*"

As for whether performance measures feed back into strategic planning, it was the customer's reaction that held sway.

> "*Well, yes, because you produce something, and then he suddenly says, well, look, if it was this price, we'd buy thousands. So if you can, then maybe you go for a volume market, then. Rather than just this one-off. So it depends how… And you're never quite sure how popular these things are going to be, because these guys can never, ever tell you how many they really want, because everybody's a segment divorced from whatever the real world is in the industry we serve.*"

A2 had indicated in the earlier series of questions that he was unaware of NPD performance measures so question 19 was phrased in terms of what he thought might be useful measures. His reply was,

> "*I think just the general, just a simple checklist, would be a good start. And probably a bit more emphasis on, when a product comes through, let's plan it. Into the factory a bit better. Let's make sure we've got jigs, let's make sure we've got the tooling to do it. I think there could be… a bit more time spent on that. It's the age-old thing. You kind of get dumped "Here you go, make it. We've designed it, and it's all great. Just make it," and "Why's it late?" We are just at the end of the chain. That's the old thing."*

When asked what he thought would be a reliable measure of NPD performance his response was,

> "*I don't know exactly what happens here but often you would cost it and price it on the way that you've set it up to run. And you don't know if it's run like that or not. But that's what you are trying to sell it at: how it should run. And I think we need to, could spend more time on concentrating – "Did it run like that?"*

When asked whether the outcomes from new product development projects fed back into strategy the response was,

> "*I think it is. But, I think it's through local knowledge. It's just. It's in people's heads of what did work and what didn't work, I reckon, as far as I know*."

A3's response to the question on the most useful performance measures was,

> "*Price usually. An example is, we've won a contract recently with [name deleted]. We have had to maintain keen pricing. Materials are going up so we needed to do work on the cost of the product. And that's fuelling, revisions to the components of that product.*"

Effectively, competition keeps prices in check and the company has to find ways of reducing costs in order to make a profit. Perhaps a more appropriate response should have been profitability. When asked about the reliability of such a measure the response was,

> "*In terms of profitability, yes."*

The profitability of particular projects also feeds back into future planning on what to quote on. With little influence over price, the company has to rely on its internal capabilities to achieve profitable outcomes –

> "*usually the biggest gains are not in the design but in the processes."*

For company A, performance measures related to NPD activity are very much outcome measures. In the main the focus is on costs and profitability. Market power

resides with the customers (government utilities). There is limited design flexibility so the company relies on process efficiency to generate profits. That said there seems to be limited communication between sales and production as evidenced by the Production Planners comment,

> "*We are just at the end of the chain.*"

The company appears to rely on tacit knowledge, "what's in people's heads", rather than formal NPD processes. The aggregative measures, ex-post, would seem to offer limited scope for this organisation to improve its NPD performance. It seems that most planning starts after a contract has been won.

6.7.2 Analysis of Company B Responses

At company B, new product projects are evaluated by the production planning team upon completion. B1 commented,

> "*if we do a new product and we've had to manufacture a one-off or a two-off or a three-off for a customer, to prove our worth, before we can get in the door, which is a lot of the case, we normally sit down at the end, and then have any pros and cons or pluses and minuses where we could have done better. ….. Generally, we discuss it on our weekly production meetings. The issues that come across the table. And if it's not sorted out during that meeting, then we'll call a separate meeting and discuss it. It's more monitored as we go.*"

Responsibility for monitoring performance lies with the technical manager (B2) who reports to the production meetings. No specific performance criteria were mentioned. His responses reinforced the uncertain nature of NPD performance measurement.

> "*It's hard to say, because we're not at that level now where we've successfully pushed through a heap of new product development. For one-offs… let's go back on a smaller scale. If we have a couple of things that come in, and they say, "Oh, we want this, and it's very small and one-offs," customer feedback is the main thing.*"

As with Company A, customer feedback seems to be an important method of assessing the success or otherwise of an NPD project. B2 also confirmed the value of weekly meetings in evaluating NPD performance.

> "*We have a weekly meeting, every week, and that job is flagged in the weekly meeting as part of a job within the company. If there are any*

issues, or anything that's needed to support that job, it can be brought up at that meeting, and then from the other department, it can be addressed or supported. But other than that, it comes down to the project leader that has to know that, has the job. He needs to do this. He knows all the steps that come out. And he's got the support behind him, but in that sort of small quantity, there is no real assessment form, right, it's all relying on the project manager."

Similar to Company A, there seems to be a reliance on the expertise and tacit knowledge of the project leader, with perhaps a more formal method of communicating lessons learnt to other people within the organisation through the regular production meetings. B3 offered a few specific criteria that need to be met.

"*Well, I guess really, the way we would evaluate here is that we can produce the product at the required lead time, and we produce an accurate product.*"

In effect, the performance criterion is meeting customer specifications, which supports the comments of B1. B3 had no specific response to the question of who measures or monitors NPD performance.

"*The way that we would be measuring our new product development pure and simply is I guess the number of projects that we're tending for and the win-loss ratio. Because this is new for us.*"

His response reflects the recent shift to focusing on external customers, and the need to develop products for them. These new products are the result of tendering for work, where a measure of 'success' is the number of projects won vs. the number of projects quoted on.

When asked what measures were most useful in monitoring and improving NPD performance, B1 replied,

"*I guess the main tools we use for measurement is really, once the job goes out and whether we get a hit over the head with a stick because we lost money, or a pat on the back because we made a fortune, because we do gross profit reports and things like that, really, on jobs, that's a lot of the main stuff we do.*"

Whilst job profitability might be a measure of performance, it is not likely to identify areas for performance improvement. When asked whether he thought job profitability was a reliable measure of performance he replied,

"*Not always. Because the way our system is here, with our scanning and stuff like that, we can… You can sort of not scan, or… I guess, back-*

door the system to make it show better or show untrue costs. So someone might have spent 20 hours on a job, but they only scan off at 10, well, it's going to look a lot better, isn't it?"

This lack of reliability in measuring project and job performance would be a barrier to process improvement. B1's responses also indicated that performance measurement of NPD projects did not impact on the strategic planning activities of the company. Furthermore, his response indicates a lack of strategic planning.

"*I don't know whether I could really ever sit down and recall a time where the company has actually said, 'Right. This is what we're going to do. This is where we're going.' I know we're targeting biomedical, and we're doing that…. But as opposed to sort of saying, 'Right, well, let's go and try this avenue now,' or see where they want to go, I don't recall that ever happening.*"

B2 also indicated an absence of useful performance measures in new product development.

"*Once again, we don't really have a hard 'yes or no' or 'one to five' performance appraisal on product development, as such. There is no set questions we ask, really, on how product development … how effective it was, or how it moved through the shop. It's quite, what we'd say, ad-lib, all right. In saying that, it's his [the project manager's] opinion on how it would work and how it should change, and at the end of the day, there could be two opinions that are probably both right, but could be also totally opposite.*"

In terms of the reliability of measurement he responded,

"*Oh, I think it could do with development, and we've never really got into it… As I said, when you're talking small quantities, close relationships to customers, personal service, it all comes down to the person who's doing the job.*"

B2 did believe that their end of project reviews fed into the strategic planning process.

"*Yes, it does. Because the review will have everybody that's needed to be there, plus everybody else that's in the company of that level that can use the information that's supplied at the meeting. So you might have three other project leaders that weren't on that project, but they can come to the meeting to listen to see what had happened at that point in time.*"

This review mechanism certainly also provides inter-project learning opportunities of the type described by Bartezzaghi et al., (1997), but the lack of measurement within the NPD process might limit opportunities for improvement. B3's response

to the question on the most useful performance measures used by the organisation to monitor and improve performance, in terms of developing its new was insightful, if not entirely relevant. He said,

> "*What we've got to do, I guess, is we've got to measure performance basically on our capability of, first of all, making and manufacturing a prototype, and then, I guess, our resources that we have available.*"

Several writers commented on the need to develop capabilities that supported new product development (Boer et al., 2001, Caffyn, 1998, Chapman et al., 2001, Matthews, 2007). B3 went on to describe activities for developing capabilities within the organisation.

> *"Putting in an action plan in place to develop those resources. Which might mean buying machinery. It could mean advertising for new [CNC] programmers. Part of it is also, …. apprentice training strategy or policy or whatever he's got in place here, where I think we've got five or six apprentices, so he's constantly looking at making sure that we fill the gaps.*"

When asked whether the company had reliable measures of NPD performance, the response was negative.

> "*Not yet! Not yet, no. At the moment, it's sort of like we'll meet, we talk about the product, we look at the drawings, we say, 'Okay', we put a plan in place, we appoint a project manager, and then he'll go away, and a week later, we'll meet again and say, 'Okay, what's the progress? Have you managed to make it? What do we need, to be able to make it?' So at the moment, I guess the way we evaluate is to sit down, and we have like a kick-off or a launch meeting. We identify what needs to be done, what product needs to be manufactured, and how we go about manufacturing it. And then we go away, we try it, and we come back, we talk about it.*"

B2 was even more positive than B2 in his belief that their measurement of NPD practices fed back into strategy.

> "*Well, definitely, yes. Definitely. Because it's during the trial process that we identify that we need… I guess we need equipment or we need resources. Then yes, that definitely shapes the strategy.*"

With Company B, performance measurement of the NPD process is in its infancy, at best. The key measures appear to be profitability, on-time delivery, and customer satisfaction, although measurement is largely subjective. On the positive side, the end-of-project review meetings do provide opportunities for inter-project learning, and capability analysis and development.

6.7.3 Analysis of Company C Responses

This company was also in the preliminary stages of trying to establish performance metrics for its new product development processes. C1 advised that she has little or no involvement in evaluating NPD performance, instead referring me to the Design and Operations functions. The response from C2 indicated that NPD performance is not measured.

> "*Well, it just gets down to how they sell, really. At this stage. I don't believe we measure it*".

His response also indicated uncertainty over what actually constituted a new product.

> "*Everyone wants the same thing, but they want it slightly wider, or slightly deeper, or slightly higher or slightly shorter, or a different handle, or… So I suppose you could sort of define those as being separate products, or you could sort of say, "No, it's the same product, but it's slightly different, and it's slightly customised."*

C3 provided a clearer indication that measurement of NPD performance was in its early stages at best.

> "*Currently, what we're trying to do is, we're setting measures, I think. Like, we're setting timelines when we take on a new project, and trying to meet deadlines. In terms of review, at the end of a project, I don't think we've really captured a lot of information about what, say, some delays in the product development cycle have been or all that sort of thing. But I don't think we're measuring performance at the end of a project as well as we could be.*"

According to C3, no responsibility for measuring NPD performance had been allocated. The Company did measure the performance of its production processes, and according to C3, this was driven by the organisation's quality system.

> "*What we're trying to do is establish – through our quality system – establish procedures to go through, to then start to capture records and that sort of thing. But I know that [name deleted] been involved in trying to get that format together so we can start to follow up on that. And like I said before also, in terms of monitoring, we're establishing these timelines or setting milestones that we've got to reach, based on dates, etc, that we can then come back to and evaluate, you know, whether we met the targets or we didn't, and why, sort of thing.*"

Measurement would appear to concentrate on productive efficiency and quality as opposed to improving NPD performance. Even where meeting delivery targets is

measured, variation from targets may be measured, but not followed up on in order to improve performance in the future. As was observed from this company's responses to questions relevant to research question 2, a lack of internal cross-functional communication may inhibit opportunities for improvement in their NPD activities.

C1 was unable to provide any information on performance metrics dealing with new product development. Typically, the response was that enquiries in this area should be directed to Design and Operations. According to C2, the most useful measure of NPD performance would be time-to-market.

> "*Oh, I suppose the most obvious one is time to market. So I suppose, if we can generate a new product iteration or modification or a change or a completely new product in a timely fashion, then that gives us a competitive edge in the market.*"

C2 indicated that whilst this measure was useful from a customer satisfaction perspective, it was not a reliable measure of NPD performance.

> "*Because every different, particular project has its own nuances. Certain things are quick to develop, because you might base it on something that you've already got, existing, so it's really not a new development, it's just a tweak of an existing product. Something could be technically quite difficult to achieve, because of size and strength, or whatever requirements that it has to fulfil. So no, you can't really go by that. But then, that's… just as a rule of thumb, if you can sort of turn things around fairly quickly, or at least quicker than what your competitors can, then it's got to be good for you.*"

Here we see that an emphasis on the process output is inhibiting the company's ability to focus on the process itself, and therefore limit its ability to improve the process. C2 did not believe that NPD performance measurement had an impact on business unit strategy. He did however say that problems in development were discussed, and might impact on future NPD strategy.

> "*It probably would. If we came across certain difficulties in that development process, we'd certainly sit down and take stock at the end of the program, to sort of say, "What things can we do better?" "If we come across a similar situation in the future, how would we handle that? How would we handle it differently in order to achieve a better result?*"

For C3, the most useful measures to monitor and improve NPD performance should centre on project management and control.

> "*I think it's in… it would be in relation to the… again, a forum of regular meetings, to discuss how projects are coming along. So, in any case, whether a project is going well, or slow, or on time, or there's been delays, what we tend to do is be sort of… you know, have regular meetings with the stakeholders, to discuss where projects and how projects are progressing. So I think the measures are taking things like minutes and designating action items for individuals to pursue, and make sure they're on top of what they're meant to be doing at the time.*"

When asked about the reliability of this measure of NPD performance, C3 replied,

> "*I think it's a start, but it's not the most reliable way I think we could be doing it. I think because we probably need to set some other way of making sure, or setting a responsibility… because currently we do it collectively, as a result of necessity, like needing to do it. Just to be able to stay on top of things. But we don't have a solid process that we follow and make sure that we're doing the correct review and measures.*"

C3 gave a negative response when asked whether NPD performance measures impacted upon strategy at the business or functional level.

Performance measurement for this organisation appears to be very much output based. Meeting delivery targets and customer specifications are the measures of success. Project monitoring appears to be important in terms of keeping a project on track, but learning opportunities from end-of-project reviews appear to be less well developed than in company B, as evidenced by the comment,

> "*We don't have a solid process that we follow and make sure that we're doing the correct review and measures.*"

6.7.4 Interview Observations: Research Question Four – Measuring NPD Performance

Evaluating NPD performance in all three respondent firms seemed to be lacking, certainly in terms of how they might go about improving their processes. For company A, the main measures related to profitability of a given project. For company B, projects were evaluated on completion though no specific performance criteria were mentioned. For both companies customer feedback was also a significant indicator of performance. With Company C, performance measurement of NPD appeared to be absent.

The data obtained for this final research question provided evidence of a significant disparity between that identified in the literature as best-practice, and that which currently exists in SMEs. The absence of performance measures that provide appropriate evaluation of their NPD processes will seriously restrict their ability to improve those processes. Data from each of the three firms have been summarised for ease of comparison in Table 6.7 below.

Table 6.7: Research Question Four Comparison Summary of Interview Findings

Measuring NPD Performance: Do SMEs measure NPD performance, and does such measurement influence strategy?			
	Company A	Company B	Company C
NPD Process Measurement	Outcome measures are used in terms of project profitability and customer satisfaction. Some uncertainty on how to measure NPD performance	No specific performance criteria. Uncertainty over how to measure NPD performance	Very little done in this area, though the need to do so has been identified
Who measures NPD activity	There is a belief that the customer is the judge of the success of their NPD activities.	Technical manager. Project teams review on completion	Project managers are responsible for monitoring performance against plan.
Usefulness of NPD metrics	No clear idea from respondents	Measures in play were not considered reliable or useful.	Valuable from a customer satisfaction perspective, but not considered reliable measures of NPD performance
Impact of measurement, if any on strategic direction	None, or tacit at best	End of project review meetings do appear to feed into strategic planning	Not considered to have an impact

6.8 Summary and Key Findings

In this chapter, material from the in-depth interviews has been presented and analysed. The questions used in the survey were designed to gather information that would complement the data obtained from the quantitative survey. The qualitative data collected from the three participating companies was extensive and provided insights into new product development practices in SMEs. Each research question was looked at separately, with the responses to the relevant questions presented on a company-by-company basis. Observations on various responses were made as the data were presented, and each section included a brief overview of the relevance and implications of the data. Conclusions were presented at the end of each section and the key research findings for each research question are now summarised as follows:

- Research question one: Senior management in these business units carries the responsibility for setting strategy, as it should. Organisational strategy was not well disseminated or understood throughout the three organisations. NPD strategy was largely driven by externalities, in particular the customer. NPD strategy was even less well understood than business unit strategy. None of the respondents could confirm an explicit link between NPD and business unit strategy.
- Research question two: Management involvement in improving NPD processes and performance was very limited. The emphasis in all companies was on productivity and quality. None of the organisations had put in place measures to evaluate their action programs. There was no evidence of plans to develop NPD capabilities.
- Research question three: These three organisations had few or no formal procedures in place for managing NPD projects. In two of the organisations there was a recognised need to adopt more formal practices. There was a clear statement from all three organisations for a need to improve communication concerning NPD activities, and to provide feedback on projects. Respondents gave mixed views on the efficacy of their NPD procedures in supporting NP projects.

- Research question four: In all three organisations, NPD activity is not evaluated. Management was uncertain on how this might be done. Outcomes of NPD projects were evaluated from a productivity and customer satisfaction perspective. None of the respondents believed that the performance metrics used in their organisations would be of value in improving their NPD processes. There was no evidence that performance measurement was used to inform strategic choices.

In the final chapter of this thesis, the data from the quantitative and qualitative surveys will be combined and conclusions on each research question will be presented. Implication for theory, policy and practice that follow from the research will also be discussed.

Chapter 7

Discussion and Conclusions

7.1 Introduction

In the previous two chapters data both quantitative and qualitative were analysed. The chapters were framed around each of the four research questions presented in chapter one. The rationale for investigating these research questions emerged from a review of the relevant literature as discussed in chapters two and three. The literature review also provided the basis for the theoretical framework presented in chapter four, within which the research questions were placed.

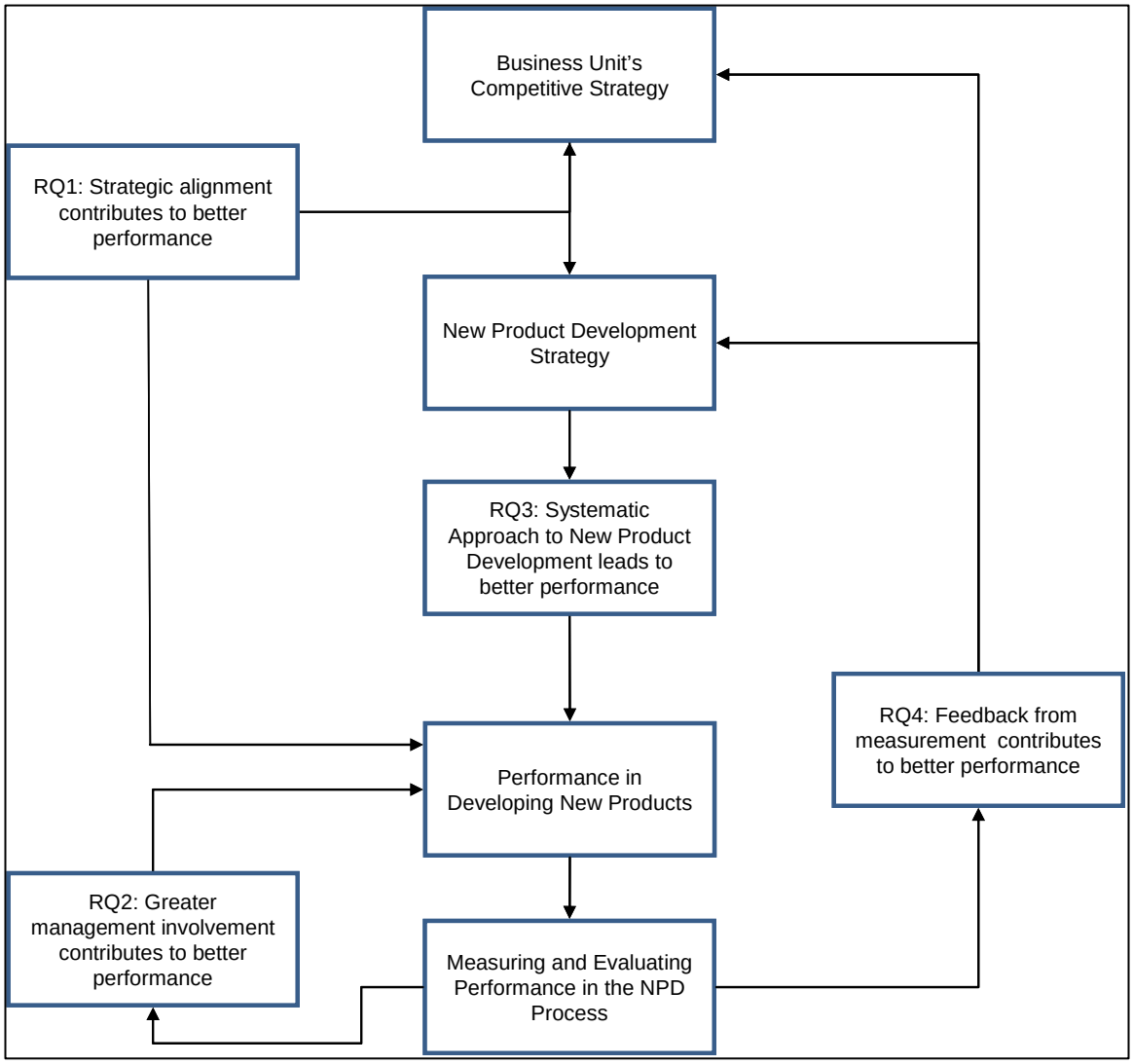
In this final chapter the findings from the quantitative and qualitative analyses are combined and discussed within the context of the four research questions. Conclusions derived from the data are evaluated against the literature reviewed in chapters two and three. This chapter also includes a discussion on the implications of the research for theory, policy and practice. Limitations that emerged during the course of the research are reviewed. The final section of this chapter provides information on opportunities for further research.

The rationale for undertaking this research was to examine new product development practices in small to medium-sized manufacturing firms against the background of previous research that concentrated in large part on innovation activities in large organisations. Four research questions were framed which focused on important aspects of new product development that were identified in the literature. The issues examined were: strategic alignment of NPD activities; management involvement in the NPD process; the impact of NPD process on outcomes; and the measurement of NPD activities. Previous studies such as those of Page (1993) and Griffin (1997) had suggested that larger organisations demonstrating strong performance in innovation and product development had evidenced effective management of these issues (see Chapters 2 and 3). The

research undertaken sought to evaluate whether similar priorities were given to these issues in SMEs.

The relationships between these concepts were shown graphically in the theoretical framework in the methodology chapter. That diagram, incorporating the research questions, is shown below. It is followed by a presentation of the conclusions concerning the various research questions.

Figure 7.1: Theoretical Framework Incorporating the Research Questions



7.2 Conclusions about the Research Questions

In the sections that follow, the conclusions drawn from the examination of the quantitative and qualitative data are examined and presented.

7.2.1 Research Question One – Strategic Alignment

For large organisations, the importance of aligning functional strategies with the business unit strategy was established in Chapter 2, section 2.5. The relevance of an integrated approach to strategy and new product development in smaller organisations should also apply. The reality of this issue in the SMEs examined as part of this research, was discussed in chapters five and six. Responses to the quantitative survey exhibited a variety of business unit competitive strategies (Table 5.2) and NPD competitive strategies (Table 5.3). The sample size used in the quantitative analysis was not considered sufficient to draw conclusions about which NPD strategy might best support a business unit strategy. Table 5.4 did however use the available data to determine the NPD strategies most used to support business strategy. Profitability, innovation and growth were the top three business unit strategies used by the sample firms; it was observed that a greater emphasis was given to a product innovativeness strategy to underpin a profitability strategy. Product functionality and product customisation were not far behind. The literature does link the uniqueness of a product (product innovativeness) and its ability to satisfy customer needs (functionality and customisation) to its market success (Cooper, 1999, Griffin, 1997). From this perspective, SMEs do seem to be pursuing appropriate strategies for successful new product development.

A review of the responses to the qualitative survey indicates that an active process of strategic alignment may not be the reason behind the choice of NPD strategies. Responses from Company A demonstrated a lack of any NPD strategy, with new product projects being somewhat opportunistic, as evidenced by A3's response "*Sales/Marketing Director or the General Manager generally see the opportunities. Sometimes they are real and sometimes they are perceived*". With this company it

was very much the case that the customer called the shots. The company responded to, rather than created new product opportunities.

Company B, being the largely independent manufacturing arm of a global business had a sound grasp of strategy. In addition to producing tooling for its parent, it was expected to develop its own external market and this is where its innovative endeavours were focused. There was uncertainty over what NPD strategy to pursue with the company in the process of shifting from a custom tooling supplier to a manufacturer of volume precision parts. The company planned to pursue new product opportunities that complemented its design capabilities. This organisation was coming to grips with the need to both market its design capabilities, and develop its manufacturing processes to move from one-off prototypes to volume production. Whilst there may have been a good alignment of business and NPD strategy, its operations strategy needed to be brought up to speed, especially in terms of implementation.

Company C respondents offered different views on what they believed the business unit's strategy was, with profitability and growth both being nominated. Two respondents could provide no information on the question of an NPD strategy, whilst the third suggested that customisation of product offerings provided support for the business unit strategy. Unlike Company A that responded to customer requirements, Company C actively scanned the external environment for business opportunities. A widely held view of the organisation's business strategy and how new product strategy might support it was lacking. When it came to choosing which opportunities to pursue, the decision resided solely with the general manager. Perhaps in recognition of the limitations of this approach, the company had decided to adopt a team-based approach to new product selection.

Despite varying levels of sophistication within the three organisations when it came to strategic planning, there was an absence of a formal process for communicating strategy throughout the organisation, even at the senior (functional) management level. Informal communication was the preferred method, and it resulted in some confusion as to what the specific business and functional objectives should be.

The quantitative data provide information on the types of strategies followed by the respondents, but were not sufficient to determine whether NPD and business units strategy are appropriately aligned. The qualitative data demonstrated that strategy, particularly NPD strategy were not widely understood. Typically no articulated NPD strategy existed. It follows then that this important functional strategy would not be aligned with the business unit strategy. The findings here support those of Lindman (2002) as discussed in section 2.8.

7.2.2 Research Question Two – Management Action Programs

In chapter two, the importance of management involvement in the new product development process was demonstrated from the perspective of developing organisational capabilities (Prahalad and Hamel, 1990). One such capability is organisational knowledge (Kay, 1993). Researchers who have examined the relationship between organisational learning, knowledge accumulation, and capability development include Caffyn (1998), Bartezzaghi, Corso et al., (1997), and Boer, Caffyn et al., (2001). In particular the CIMA model, described in detail in section 2.7, refers to the use of management interventions (levers) as a means of improving NPD performance. In this section conclusions are drawn from the data gathered on management involvement in improving new product development processes and performance.

An examination of the quantitative data was undertaken in section 5.3. In Table 5.6 data were presented on the degree of effort that various SMEs put into various NPD action programs. These types of management involvement demonstrate a preference for proven methods of improving performance via the introduction of externally developed processes and technologies. Adoption of such action programs was widespread across the firms surveyed.

Less widely used management action programs involved the development of teams and employee commitment, where ten or fewer of a possible 37 firms reported any degree of effort. This is possibly of some concern given the importance placed on team-based activities in developing new products (Imai et al., 1985, Lynn, 1998).

The surveyed firms appear to be avoiding 'soft' options when it came to action programs.

As well, action programs with an external focus, such as supplier participation, involvement with universities and research institutes, administrative routines, non-computerised tools and techniques, and benchmarking, were at the bottom of the list. Finally, despite the importance of meeting customer requirements when developing new products, as identified in the previous research question, customer participation in the NPD process does not appear in the top half of action programs amongst the surveyed firms. It is possible that customer involvement came via the conduit of the participation of marketing/sales in NPD, which ranked third overall in terms of effort placed in action programs.

When the data on past action programs were compared to the perceived benefits of those programs, and the effort expected to be placed into future action programs some strong correlations emerged (see Section 5.3.3). One conclusion to be drawn from this is that SMEs are comfortable with action programs that they believe are beneficial, and will continue to invest in them. This ongoing investment in specific action programs could result in the development of capabilities that support NPD. On the other hand, the limited scope of action programs within some organisations could restrict the development of relevant NPD capabilities.

The qualitative interviews sought to identify the drivers and inhibitors to various action programs with SMEs. In the case of a team-based approach to developing new products, inhibitors appear to be a lack of resources, specifically time, and a lack of a recognised new product development process. Strong functional divides appear to be an inhibitor to effective and sustained teamwork in this organisation.

With regard to other action programs, these tended to be firm specific. The main emphasis in terms of NPD action programs was CAD tools which were intended to reduce product cycle time. Nevertheless, there were no formal, planned action programs. As A2 said, *"we have this 'squeaky wheel gets the oil' approach"*

Company B had a number of action programs running including, project management, quality, and improvements in CAD/CAM. Of these, quality was an ongoing program given the precision nature of their work, and probably not directly related to improving NPD performance. It was however a definite capability that generated opportunities to work with a variety of potential new customers and products.

In Company C, action programs that supported New Product Development were not considered to be within the scope of the sales function, with engineers and designers having direct contact with customers. Customer participation in NPD receives their attention when it comes to new product development programs. Both C1 and C3 confined their discussion of action programs to their functional areas. C2 seemed to have a better overall view of their NPD activities, and indicated that the main drivers for their programs were either specific customer requirements or productivity and efficiency.

Both the quantitative and qualitative data identified a preference for formal management approaches such as ISO9000 and project management. Managers were also comfortable with off-the-shelf solutions such as software programs, or the technology embodied in machinery. What was interesting from the qualitative interviews was that there was not conscious connection linking these action programs with efforts specifically targeted at improving NPD performance. These SMEs concentrated on bottom line performance rather than improvements in specific functional areas.

The action programs that were employed certainly contributed to capability development. These findings support the research of Caffyn (1996) who identified capability development as necessary for continuous improvement within the NPD process. Since most of the firms that participated in this research were involved with incremental innovation, developing capabilities is an appropriate method of improving NPD performance.

The action programs used by these organisations had some important omissions, in particular team-based action programs, and those that included customer

involvement. Action programs along these lines would address the concerns raised by respondents in the detailed interviews about the need for improved communication.

Another observation derived from the data was that none of the organisations that participated in the in-depth interviews evaluated the effectiveness of their various action programs. It seems clear from the interviews that SMEs do not quantitatively measure their action programs. This should not be interpreted as being at odds with the results obtained from the quantitative survey. There, respondents were asked to rank the benefit (in terms of improved performance) that their various action programs generated. These were necessarily subjective and not based on quantifiable data. The conclusion relevant to research question two is that action programs are selected based on their likely value to the organisation, rather than as targeted efforts to improve NPD performance.

7.2.3 Research Question Three – Management of NPD Projects

This research question involved an investigation of the management processes in place in SMEs that dealt with new product development. Various models of the new product development process were reviewed in section 2.3, and section 2.6 presented a variety of sources that supported the importance of adopting some sort of a structured approach to successful NPD outcomes. The results obtained from both the quantitative and qualitative surveys are now discussed.

Using the quantitative data, a comparison was made between firms that reported an NPD process that they categorised as systematic, or containing many procedures, against those firms that reported very few or no formal procedures. These responses were compared against the same firms' responses to a question on the innovativeness of their organisation, as measured by their position in introducing new products to the market as either leaders or followers. No discernible difference could be statistically asserted between the SMEs that were sampled. Two other variables were compared against the NPD process employed within these SMEs, those being 'reputation' and 'time-to-market' performance.

The reputation of the SMEs did not appear to be influenced by the NPD processes employed within the organisation, indicating that their customers are perhaps more concerned with the outcome than how it is achieved. It could also be that personal contacts are more relevant for SMEs. It is also likely that their customers are not so much concerned with how things are done so much as that their requirements are met.

Analysis of the quantitative data provided no evidence of a significant difference in overall business performance resulting from the degree of formality employed in NPD projects. However, it appeared that SMEs do benefit from a more systematic approach to NPD project management in certain areas, specifically time-to-market performance, as discussed in section 5.4.4. The improved time-to-market outcome emerging from systematic management of NPD projects was also observed in research conducted in large organisations (Cooper et al., 1999).

All respondents were forthcoming with suggestions on how their NPD process might be improved, which is a good indicator of the need for greater formality. Their different perspectives on NPD would seem to indicate that a more unified approach needed to be developed.

What was evident from the qualitative interviews, was that individuals differ in their assessment of what constitutes a formal system. Different functional areas seem to have better developed processes when it comes to handling new projects. Departments that interface with customers seem to view their activities as more formal. Operational areas that have to manufacture the new products see them as disruptive, and the procedures for introducing them as informal. The need to learn from new product projects was a common theme put forward by at least one respondent in each organisation.

One likely reason for the different approaches employed in managing NPD projects is the level of complexity involved. With most SMEs' NPD projects being incremental, a less formal approach is needed. Nevertheless, the disproportionate

functional approach to managing NPD projects indicates that SMEs should pay closer attention to organisation-wide needs in this important area.

7.2.4 Research Question Four – Measuring NPD Performance

Measuring business performance has presented challenges for all organisations. The literature on performance measurement is extensive, so much so that it warranted a separate chapter to review the relevant literature. Of particular interest to this research was the measurement of innovation, and more specifically, new product development activities. The quantitative questionnaire sought to obtain data on the types of measures used to assess NPD performance. These were discussed in section 5.2.3 and displayed in Table 5.5. The respondents to the quantitative survey provided their subjective opinions on how performance had improved across a range of performance dimensions, relative to three years previously. These responses were based on opinion rather than factual data. Even where factual data might be collected it does not necessarily imply that such data would used to improve performance or influence strategy. The interviews were used to explore in greater detail the use and effectiveness of various performance metrics relative to the organisations' new product development processes. The conclusions reached from analysing the data on performance measurement are now discussed.

The qualitative data provided useful insights into performance measurement practices in SMEs. As distinct from the broad range of metrics that were reported as being used by respondents to the quantitative questionnaire, the interviews revealed a much narrower focus. Indeed, several respondents indicated that they were unaware of any specific measures for NPD performance. Conclusions based on their replies are discussed below.

The fourth research question investigated whether SMEs measure NPD performance. The quantitative survey demonstrated that data were collected across a range of metrics. However, it was clear from the qualitative survey responses that new product development performance was not adequately evaluated. When asked specifically about performance measurement of NPD activities, the overwhelming

response was that outcomes, not activities were measured. These outcome measures were either cost related or performance related. Performance was determined by the customer, and whether or not they were satisfied with the outcome. The data that was analysed would be of little use in improving NPD performance.

Responses to the qualitative interviews indicated a lack of understanding of performance measures relevant to NPD activities. Several respondents were unaware of any NPD performance measures (Respondents A2, B1, B2, C1, C2, and C3) that specifically evaluated their NPD processes.

In general, the responses to interview questions dealing with performance measurement point to some substantial differences between SMEs and larger organisations when it comes to developing new products. One reason for this is that the impetus for new products came from outside the firm. It is hardly surprising then that valid measures of NPD success for these firms are customer satisfaction and the ability to meet the customers' requirements at a profit. Larger organisations that have a greater involvement with the broader management of innovation from concept to market launch would necessarily need to emphasis NPD process measures to a greater extent. SMEs however could be limiting their opportunities to be truly innovative by moving too far along the path of customer dependency, as discussed in section 2.8.

Also under investigation was whether NPD measurement was used to inform strategy. Overall, most of the 37 organisations that provided data on NPD performance were able to provide an opinion on their performance across the range of performance metrics listed in Appendix M. In section 5.5 certain of these data collected from the quantitative questionnaires were analysed in order to determine whether performance measures influenced strategy or future action programs. That analysis revealed that future action programs were not influenced by NPD outcomes.

The data appear to be saying that even though SMEs might evaluate NPD performance, that analysis is not used for process improvement or strategy formulation. This has implications for the long term viability of the SMEs because

both process improvement and strategy formulation were linked to organisational learning and long term success in the literature. Learning might be occurring at the level of the individual, but not at the organisational level. Whether this translates into capability development is uncertain.

The findings relevant to the four research questions have been reviewed. To a large extent, the four important issues examined in this thesis in managing new product development processes in large organisations also hold for SMEs. With customers largely dictating the configuration of new products, manufacturing SMEs tend to have a limited view of what constitutes a new product. The implications based on these findings will now be presented.

7.3 Implications for Theory

The theoretical underpinning of strategic alignment of business unit and NPD strategy is that it is an active process, where the choices of which NPD projects to pursue is determined by their 'fit' with the overall business strategy. The literature on innovation in large organisations points to this alignment as representing best practice. Small organisations of the type that were represented in this research appeared not to fully appreciate the relationship between their overall business strategy and their choice on new product projects. There appeared to be a great deal of uncertainty over NPD strategy.

One positive point that emerged from the research was the SMEs' awareness of the need to develop their competitive capabilities in order to better meet their customers' needs for a sound partner when seeking a manufacturer for their new products. From a theoretical perspective, action programs that enhance the SMEs' competitive capabilities need to be better understood.

Innovation management in large organisations can cover the entire process from idea through to commercialisation. Much the process is managed in-house, or through some form of collaboration. Small organisations tend concentrate on a very narrow part of the new product development process. In the case of small to medium-sized manufacturing firms, the emphasis is necessarily on the production

stage. It was not uncommon during the data collection for this thesis that respondents denied that they were involved in developing new products. They saw their involvement as making something to their customer's specifications, and even if it was something they had never made before, they usually did not consider it in terms of new product development or an innovation for their firm.

When reviewing performance measurement within SMEs, the organisations tended to emphasise outcome measures such as profitable completion of customer's orders, and customer satisfaction. Such measures would seem to encourage a dependency on satisfying existing customers, rather than building capabilities that would enable the SMEs to broaden their customer base. If this is the case, such firms could be heading towards the customer dependency described by Raymond and St-Pierre (2004), as discussed in Chapter 2, Section 2.8.. They can perhaps avoid this by having more clearly defined business and NPD strategies that are supported by appropriate action programs to develop capabilities that appeal to a broader customer base. Further they need to develop performance measures that emphasise capability development and not just customer-specific outcomes.

7.4 Implications for Policy and Practice

Many observations can be made from a review of the responses provided in the in-depth interviews. A review of the conclusions drawn from the first research question indicates a lack of strategic direction among senior managers. This lack of awareness of strategy points to a need for these SMEs to communicate business unit strategy throughout the organisation. These firms need to better understand the relationship between business unit strategy and functional strategies. Specifically, the firms should look at their strategy development and deployment procedures.

The conclusion from research question two is that action programs that might improve new product development performance in SMEs seem not to be well targeted. This may be because the managers interviewed tended to emphasis efficiency and cost reduction programs. Their programs were not seen in terms of investments in capability development. Very few of the respondents saw their action programs as impacting on NPD performance. If this is the case, firms have at

least two options. They can pursue work that complements existing capabilities, which might limit their long-term prospects, or they can develop capabilities that enhance growth prospects. They could, of course, choose to do both. The three firms that contributed qualitative data generally had sound production processes, as evidenced by their ISO9000 accreditation. However, given the importance of their interactions with their customer base, there was clearly room for building capabilities in that area.

The organisations tended to be internally focused, again emphasising operational efficiency. In the area of NPD however, a greater emphasis should be made on external opportunities. Two ways that organisations might do this would be through formal action programs emphasising inward technology transfer on the supply side, and to include customers in the NPD process on the demand side.

The responses to questions on teamwork also indicated a need for firms to address deficiencies in this important area. Competencies in these SMEs seemed to reside in individuals, rather than teams or the organisation. Networking within the firms was tacit rather than formal. This creates fragile structures that can be adversely affected by the departure, for whatever reason, of key personnel. Managers need to spread knowledge and capabilities across teams and functions to minimise disruption from the loss of 'key personnel'.

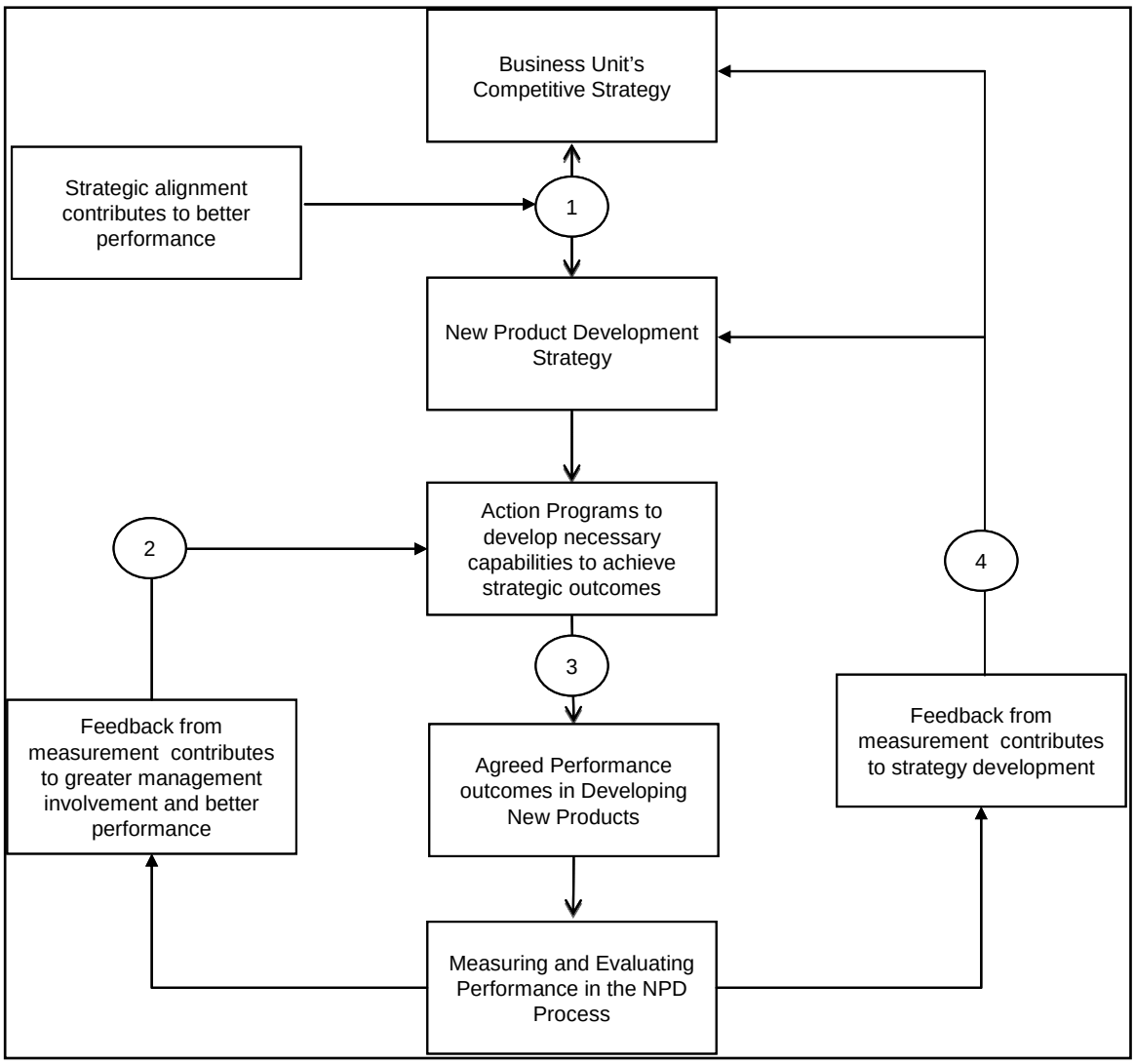
The quantitative survey indicated that action programs were widespread. The interview data indicate that action programs are not well understood in the context of developing NPD capabilities. Action programs were often a response to an identified need, rather than being developmental. They were generally viewed as opportunities for achieving operational efficiencies, e.g., new CAD systems, rather than as developing capabilities. Few if any of the action programs that were discussed in the qualitative interviews were directed at improving the firms NPD process. Practitioners need to be more aware of the value of action programs in developing capabilities. Secondly the importance of a cross-functional team-based approach to capability development needs to be appreciated in terms of its contribution to organisational learning.

The value of employing a formalised NPD process in SMEs was not clear cut, nevertheless some common elements did emerge as being necessary. Respondents from all three companies commented on the need to be more aware of business opportunities. Firms therefore need to develop mechanisms for scanning the external environment as part of their approach to improving NPD performance. Respondents universally spoke of the need to review and evaluate project performance. Firms need to establish a systematic process for developing appropriate measures for assessing NPD performance. Further, they need to have in place mechanisms for disseminating performance outcomes and lessons learnt throughout the organisation.

An examination of performance measurement of NPD processes in SMEs was the final item explored in the research. It was evident that firms need to review the outcomes of their action programs in order to evaluate their effectiveness in building capabilities, and in deciding which action programs to pursue in the future. Whilst measurement does take place, it is questionable whether it is actionable. Performance metrics tended to be outcome based rather than process based, thus limiting their usefulness in terms of feedback for process improvement. Given the importance of satisfying customers, SMEs need to develop a range of customer related performance metrics. Overall, performance measurement seemed to be poorly understood in terms of its value as a mechanism for both performance improvement, and strategy development.

Given that the manufacturing SMEs that participated in this research tend not to emphasise important issues such as strategic alignment, developmental action programs, or performance measurement, there is much scope for improvement. One approach that such organisations could adopt to help overcome these shortcomings would be to integrate them in their strategic plans. A modified version of Figure 7.1, shown below as Figure 7.2 could form the basis of a flow chart to ensure that relevant activities are not overlooked.

Figure 7.2: A process for Integrating Strategy, Actions and Performance Measurement to Improve NPD Performance in SMEs



The personnel who participated in the in-depth interviews often had difficulty in seeing how the various issues under investigation tied together. Certainly, an understanding of innovation management in large organisations is of limited use to SMEs. What would be of value to them is a procedure that enabled them to identify important issues to be covered when considering their NPD activities. Figure 7.2 provides a visual of how these concepts should be integrated.

The discussion thus far has concentrated on implications for practice. This research focused on manufacturing SMEs, but there are a wide range of SMEs that specialise in specific activities that exist along the innovation continuum described in Chapter

2, Section 3. These include market research, design, testing and advertising firms to name a few. From a policy perspective there is clearly scope for educational programs to raise the awareness of SMEs in terms of the role they play in the wider new product development process. SMEs that are able to differentiate NPD actions from 'business-as-usual' will be better placed to track development costs and obtain appropriate financial assistance, which in turn can support ongoing capability development.

7.5 Limitations

One of the advantages of this research was its use of well established theoretical linkages between the various elements of the model shown in Figure 4.2 and 7.1. This research sought to investigate whether those linkages were as well understood in SMEs. It became clear in the course of the qualitative interviews that they are not. This study was limited to manufacturing SMEs, which are only a small, though important subset, of all SMEs. As such, the findings may not be generalisable to all SMEs. The sample size for the quantitative survey was a rather modest 39 firms, and no randomised sampling of firms from industry sectors was possible so no generalisable outcomes for sectors or regions is possible. The research did open up some interesting avenues for further research that are discussed in the final section that follows.

Another limitation of this research was in using a benchmarking instrument to collect quantitative data. The data was useful in obtaining general information on NPD practices in SMEs, but of limited use in developing an understanding of the interactions between the variables depicted in the theoretical construct. For these issues qualitative research is essential. What was evident from the qualitative interviews was that differing educational backgrounds and work experience impacted on respondents' understanding of the variables. Respondents had a tendency to shift the conversation and responses towards familiar ground. A lack of understanding of NPD processes would see them instead talk of non-NPD processes. It was important to have a pre-planned series of questions to fall back on.

7.6 Implications for Further Research

Several opportunities for further research have emerged from this exploratory study of NPD practices in SMEs.

There is scope to examine the theoretical linkages in other SME categories to determine whether the findings are more generalisable.

In this study, the issue of strategic alignment was explored. Whilst quantifiable data was collected to identify what popular business unit and NPD strategies were being followed, the data were not useful in assessing the level of strategic alignment between the two. Collecting aggregative, quantifiable data is not an appropriate method for evaluating this strategic alignment in SMEs so future research on this important issue should be carried out using in-depth interviews in relevant organisations. Such research should seek to gather substantial data on both the organisations and the respondents within those organisations so that contingencies can be identified and examined in order to provide useful data with which to explain differences in approaches between the various organisations.

Given the overall innovation management process, and the fact that SMEs tend to be involved in only a small section of it, there is certainly scope to consider innovation management in a supply chain context. From this perspective, greater emphasis needs to be placed on the linkages between firms. Certainly, this research highlighted issues of customer dependency and the importance of the customer in instigating NPD and evaluating NPD performance in manufacturing SMEs. From a supplier perspective, there are issues of technology and capability development that are worthy of further study.

In the case of large organisations, the empirical research supports the view that a systematic approach to managing NPD activity leads to better outcomes (Cooper and Kleinschmidt, 1986). The data collected for this research provided a less clear-cut outcome. Size would appear to be an important variable when it comes to the way in which NPD projects are managed. Future research should look to identify an appropriate process for managing NPD projects where SMEs are involved.

An important issue was identified when examining the use of performance measures in SMEs. The measures employed tended to be outcome measures, specifically profit and customer satisfaction measures. From a theoretical perspective, it would be interesting to investigate whether SMEs that emphasise outcomes-based performance measures, rather than process-based metrics that emphasise capability development, are more likely to travel along a path towards greater customer dependency of the type described in Chapter 2, Section 2.8.

7.7 Contributions of the Research

Whilst the conclusions have been presented in the previous sections along with the discussion of the research findings, the final section of this report will summarise the contributions that this study has made.

The study sought to extend the field of research in innovation management, and specifically new product development by investigating whether the findings from research into best practice in large organisations were also valid for SMEs.

The importance of strategic alignment between business unit and NPD strategy has long been identified as an important success factor in large organisations. More recent studies have also identified a new product development strategy and a strategic orientation as being beneficial for SMEs (Huang et al., 2002, O'Regan et al., 2006). This study examined the existing literature by exploring strategic alignment between business strategy and NPD strategy. No research was identified that examined strategic alignment of business unit strategy and NPD strategy, so the work undertaken here provides an original contribution in this important area. The research findings were that strategic alignment is at best passive. Further, strategy seems to be not well disseminated in SMEs.

The research further investigated capability building activity in SMEs via the use of action programs by managers. Little prior research had been done in this area and the data obtained for this study are very much exploratory. It seems that the SMEs contributing to this research were not concerned with developing their NPD capabilities. This study adds to knowledge of capability development, or the lack

thereof, in SMEs. The manufacturing SMEs that participated in this research depended in the main on larger distributers or manufacturers. In the main these larger customers drove innovation within the SMEs, which tended to be incremental. What emerged was a picture of the need for these SMEs to have clear lines of communication with their customers in order to ensure that they delivered to specifications. As well as having the capability to manufacture, they also needed good communication capabilities at the design and engineering level. The approach in the SMEs was to invest in supporting technologies such as CAD. Whilst the literature contains substantial material on the importance of communication, there has been limited investigation on the types of action programs that might be used to develop NPD processes within SMEs. The discussion relevant to research question two provides new insights into this important area.

The approach taken in managing the NPD process in SMEs was also studied in this thesis. In large organisations a systematic approach to NPD was seen to be beneficial. For SMEs, the result seems less conclusive. The data from the firms contributing to this research, demonstrated no statistically significant difference in performance irrespective of whether the process employed was informal or systematic. During the literature review, no prior work on this topic was identified, so this investigation provides an initial contribution in this area.

Finally, the research sought to determine whether SMEs measure NPD performance and use such data to determine the future direction of the organisation. The interview data clearly showed that NPD processes are not evaluated. Outcomes were measured in terms of customer satisfaction or profitability, but these measures did not influence future strategic direction. Even where data were collected they were rarely actioned. The research also pointed to possible causes for the poor use of performance measurement within SMEs, largely from respondents to the in-depth interviews. The main reasons cited were lack of resources, lack of understanding of the NPD process, and lack of knowledge on how to measure its effectiveness. Investigation of this research question advances knowledge concerning the use or lack thereof of performance measures to evaluate business processes, in this instance NPD processes in SMEs.

List of References

ABERNATHY, W. J. & UTTERBACK, J. M. (1978) Patterns of Industrial Innovation. *Technology Review,* 80**,** 40.

ALEGRE, J., LAPIEDRA, R. & CHIVA, R. (2006) A measurement scale for product innovation performance. *European Journal of Innovation Management,* 9**,** 333.

ALLOCCA, M. A. & KESSLER, E. H. (2006) Innovation Speed in Small and Medium-Sized Enterprises. *Creativity and Innovation management,* 15**,** 279-295.

ANSOFF, H. I. (1968) *Corporate strategy : an analytic approach to business policy for growth and expansion* Harmondsworth, Penguin.

AUSTRALIA BUREAU OF STATISTICS (2002) 1321.0 - Small Business in Australia, 2001

AUSTRALIAN BUREAU OF STATISTICS (2008a) Innovation, Information and Communication Technology (ITC) Statistics Glossary.

AUSTRALIAN BUREAU OF STATISTICS (2008b) Research and Experimental Development (R&D) Statistics glossary.

BAKER, W., E. & SINKULA, J., M. (2007) Does Market Orientation Facilitate Balanced Innovation Programs? An Organizational Learning Perspective. *The Journal of Product Innovation Management,* 24**,** 316.

BARTEZZAGHI, E., CORSO, M. & VERGANTI, R. (1997) Continuous improvement and inter-project learning in new product development. International Journal of Technology Management, 13, 116.

BERTHON, P., HULBERT, J. M. & PITT, L. (2004) Innovation or customer orientation? An empirical investigation. *European Journal of Marketing,* 38**,** 1065.

BOER, H., CAFFYN, S., CORSO, M., COUGHLAN, P., GIESKES, J., MAGNUSSON, M., PAVESI, S. & RONCHI, S. (2001) Knowledge and Continuous Innovation: the CIMA Methodology. *International Journal of Operations and Production Management,* 21**,** 490-503.

BONSDORFF, C. V. & ANDERSIN, H. E. (1995) Supporting the Business Process Management Paradigm by Means of Performance Measurements. *Concurrent Engineering: A Global Perspective.* McLean, VA. USA.

BOOZ, ALLEN & HAMILTON (1968) Management of New Products. New York, Booz, Allen, and Hamilton.

BOOZ, ALLEN & HAMILTON (1982) New Products Management for the 1980s. Chicago, Booz, Allen, and Hamilton.

BOWEN, H. K., CLARK, K. B., HOLLOWAY, C. A. & WHEELWRIGHT, S. C. (1994) Development Projects: The Engine of Renewal. *Harvard Business Review,* 72**,** 13.

BROWN, M. G. & SVENSON, R. A. (1988) Measuring R&D Productivity. *Research Technology Management,* 31**,** 11-15.

BROWN, S. L. & EISENHARDT, K. M. (1995) Product Development: Past Research, Present Findings, and Future Directions. *Academy of Management Journal,* 20, 343-378.

BROWN, W. B. & GOBELI, D. (1992) Observations on the Measurement of R&D Productivity: a Case Study. *IEEE Transactions on Engineering Management,* 39.

BURGELMAN, R. A., CHRISTENSEN, C. M. & WHEELWRIGHT, S. C. (2004) *Strategic Management of Technology and Innovation,* Boston, McGraw-Hill Irwin.

BUTLER, R. J. (1991) *Designing Organizations: A Decision-Making Perspective,* London, Routledge.

BUTLER, R. J., PRICE, D. H. R., COATES, P. D. & PIKE, R. H. (1998) Organizing for Innovation: Loose or Tight Control? *Long Range Planning,* 31**,** 775-782.

CAFFYN, S. J. (1996) Continuous Improvement and the New Product Development Process. *R&D Management Conference on Quality and R&D.* Enschede, University of Enschede.

CAFFYN, S. J. (1997) Extending Continuous Improvement to the New Product Development Process. *R&D Management,* 27**,** 253-267.

CAFFYN, S. J. (1998) The Scope for the Application of Continuous Improvement to the Process of New Product Development. Brighton, University of Brighton.

CHAPMAN, R. L. & O'MARA, C. E. (2001) Product Innovation in SMEs - Key Behaviours and Performance Measures. *(PICMET).* Portland, Oregon, USA.

CHAPMAN, R., L., O'MARA, C. E., RONCHI, S. & CORSO, M. (2001) Continuous product innovation: A comparison of key elements across different contingency sets. *Measuring Business Excellence,* 5**,** 16.

CHIESA, V., COUGHLAN, P. & VOSS, C. A. (1996) Development of a Technical Innovation Audit. *Journal of Product Innovation Management,* 13**,** 105-136.

CHIVA, R. & ALEGRE, J. (2005) Organizational Learning and Organizational Knowledge: Towards the Integration of Two Approaches. *Management Learning,* 36**,** 49.

CHRISTENSEN, C. M. (1999) *Innovation and the General Manager,* Boston, Irwin McGraw-Hill.

CHRISTENSEN, C. M. (2003) *The innovator's dilemma : when new technologies cause great firms to fail,* Cambridge, MA, HBS Press.

COOPER, J., R. (1998) A multidimensional approach to the adoption of innovation. *Management Decision,* 36**,** 493.

COOPER, R. G. & KLEINSCHMIDT, E. J. (1986) An investigation into the new product process: Steps, deficiencies and impact. *Journal of Product Innovation Management,* 3**,** 15.

COOPER, R. G. & KLEINSCHMIDT, E. J. (1987) New Products: What Separates Winners from Losers? *Journal of Product Innovation Management,* 4**,** 169-184.

COOPER, R. G. & KLEINSCHMIDT, E. J. (1994) Determinants of Timeliness in Product Development. *Journal of Product Innovation Management,* 11**,** 381-396.

COOPER, R. G. & KLEINSCHMIDT, E. J. (1996a) Winning Businesses in Product Development: The Critical Success Factors. *Research Technology Management,* 39**,** 18-29.

COOPER, R. G. & KLEINSCHMIDT, E. J. (1996b) Winning businesses in product development: The critical success factors. *Research Technology Management,* 39**,** 18.

COOPER, R. G. (1979) The Dimensions of Industrial New Product Success and Failure. *Journal of Marketing,* 43**,** 11.

COOPER, R. G. (1983) The new product process: an empirically based classification scheme. *R&D Management,* 13**,** 13.

COOPER, R. G. (1988) *Winning at New Products,* London, Kogan Page.

COOPER, R. G. (1994) New Products: The Factors that Drive Success. *International Marketing Review,* 11**,** 17.

COOPER, R. G. (1999) The Invisible Success Factors in Product Innovation. *Journal of Product Innovation Management,* 16**,** 115-133.

COOPER, R. G., EDGETT, S. J. & KLEINSCHMIDT, E. J. (1999) New product portfolio management: Practices and performance. *The Journal of Product Innovation Management,* 16**,** 19.

CORSO, M. & PAVESI, S. (2000) How management can foster continuous product innovation. *Integrated Manufacturing Systems,* 11**,** 199.

CORSO, M. (2002) From product development to Continuous Product Innovation: Mapping the routes of corporate knowledge. *International Journal of Technology Management,* 23**,** 322.

CORSO, M., MARTINI, A., PAOLUCCI, E. & PELLEGRINI, L. (2003) Knowledge management configurations in Italian small-to-medium enterprises. *Integrated Manufacturing Systems,* 14**,** 46.

CRAWFORD, C. M. & DI BENEDETTO, C. A. (2003) *New Products Management,* Boston, McGraw Hill.

CROSS, K. F. & LYNCH, R. L. (1992) For Good Measure. *CMA,* 66**,** 4.

CURTIS, C. C. & ELLIS, L. W. (1998) Satisfy Customers While Speeding R&D *and* Staying Profitable. *Research Technology Management,* 41**,** 23-27.

DANNEELS, E. (2004) Disruptive Technology Reconsidered: A Critique and Research Agenda. *The Journal of Product Innovation Management,* 21**,** 246.

DI BENEDETTO, C. A. (1999) Identifying the Key Success Factors in New Product Launch. *Journal of Product Innovation Management,* 16**,** 530-544.

DIXON, J. R., NANNI, A. J. & VOLLMANN, T. E. (1990) *The New Performance Challenge,* Homewood, Ill., Business One Irwin.

ECCLES, R. G. (1995) The Performance Measurement Manifesto. IN HOLLOWAY, J., LEWIS, J. & MALLORY, G. (Eds.) *Performance Measurement and Evaluation.* London, Sage Publications.

EVANS, J. R. & LINDSAY, W. M. (2008) *Managing for Quality and Performance Excellence,* Mason, Ohio, Thomson South-Western.

FITZGERALD, L., JOHNSTON, R., BRIGNALL, S., SILVESTRO, R. & VOSS, C. (1992) Performance Measurement in Service Businesses. IN DRURY, C. (Ed.) *Management Accounting Handbook.* London, Butterworth Heinmann.

FLAMHOLTZ, E. (1996) Effective Organizational Control: A Framework, Applications, and Implications. *European Management Journal,* 14**,** 596-611.

FLYNN, B. B., SCHROEDER, R. G. & SAKAKIBARA, S. (1994) A framework for quality management research and an associated measurement instrument. *Journal of Operations Management,* 11**,** 28.

FRANCIS, P. H. (1992) Putting Quality into the R&D Process. *Research Technology Management,* 35**,** 16.

GIESKES, J. (2001) *Learning in Product Innovation Processes,* Enschede, University of Twente.

GOODRICH, N. & AIMAN-SMITH, L. (2007) What does your most important customer want? *Research Technology Management,* 50**,** 26.

GORDON, L. A. & NARAYANAN, V. K. (1984) Management Accounting Systems, Perceived Environmental Uncertainty and Organization Structure: An Empirical Investigation. *Accounting, Organizations and Society,* 9**,** 33.

GRIFFIN, A. & HAUSER, J. R. (1993) The Voice of the Customer. *Marketing Science,* 12**,** 1-27.

GRIFFIN, A. & PAGE, A. L. (1993) An Interim Report on Measuring Product Development Success and Failure. *Journal of Product Innovation Management***,** 291-308.

GRIFFIN, A. & PAGE, A. L. (1996) PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure. *Journal of Product Innovation Management,* 13**,** 19.

GRIFFIN, A. (1993) Metrics for Measuring Product Development Cycle Time. *Journal of Product Innovation Management***,** 112-125.

GRIFFIN, A. (1997) PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practice. *Journal of Product Innovation Management,* 14**,** 429-459.

HARDINGHAM, R. P. (1970) A simple model approach to multi-project monitoring. *R&D Management,* 1**,** 43-47.

HART, S. J. & BAKER, M. J. (1994) The multiple convergent processing model of new product development. *International Marketing Review,* 11**,** 16.

HART, S. J. (1993) Dimensions of success in new product development: an exploratory investigation. *Journal of Marketing Management,* 9**,** 26.

HUANG, X., SOUTAR, G. N. & BROWN, A. (2002) New Product Development Processes in Small and Medium-Sized Enterprises: Some Australian Evidence. *Journal of Small Business Management,* 40**,** 16.

HUGHES, G. D. & CHAFIN, D. C. (1996) Turning new product development into a continuous learning process. *Journal of Product Innovation Management,* 13**,** 89-104.

HUGHES, L. P. (1999) Regional Systems of Innovation Theory and Practice. *School of Communication.* Waterloo, University of Waterloo.

IMAI, K., NONAKA, I. & TAKEUCHI, M. (1985) Managing the New Product Development Process: How Japanese Companies Learn and Unlearn. IN CLARK, K. B., HAYES, R. H. & LORENZ, C. (Eds.) *The uneasy alliance: Managing the productivity-technology dilemma.* Boston, MA., Harvard Business School Press.

JOHNSON, H. T. & KAPLAN, R. S. (1987) *Relevance lost: the rise and fall of management accounting,* Boston, Mass, Harvard Business School Press.

JOHNSTON, R. & HAWKE, G. (2002) Case Studies of Organisations with Established Learning Cultures. Adelaide, National Centre for Vocational Education Research.

JONES, T. (2002) *Innovating at the Edge: How Organisations Evolve and Embed Innovation Capability,* London, Butterworth-Heinemann.

JULIEN, P. A. (1998) *The State-of-the-Art in Small Business and Entrepreneurship,* Aldershot, Ashgate.

KAHN, K., B. (2001) Market orientation, interdepartmental integration, and product development performance. *The Journal of Product Innovation Management,* 18**,** 314.

KAPLAN, R. S. & NORTON, D. P. (1992) The Balanced Scorecard - measures that drive performance. *Harvard Business Review***,** 71-79.

KAPLAN, R. S. & NORTON, D. P. (1993) Putting the balanced scorecard to work. *Harvard Business Review,* 71**,** 134.

KAPLAN, R. S. & NORTON, D. P. (1996a) *The Balanced Scorecard - translating strategy into action,* Boston, MA., Harvard Business School Press.

KAPLAN, R. S. & NORTON, D. P. (1996b) Using the Balanced Scorecard as a Strategic Management System. *Harvard Business Review,* 74**,** 11.

KARLSSON, C. & OLSSON, O. (1998) Product innovation in small and large enterprises. *Small Business Economics,* 10**,** 31.

KAY, J. A. (1993) *Foundations of Corporate Success; how business strategies add value,* Oxford, Oxford University Press.

KERKLAAN, L. A. F. M., KINGMA, J. & KLEEF, F. P. J. V. (1994) *De cockpit van de organisatie,* Deventer, Kluwer Bedrijfswentenschappen.

KERSSENS-VAN DRONGELEN, I. C. (1999) *Systematic Design of R&D Performance Measurement Systems,* Enschede, University of Twente.

KESSLER, E. H. & CHAKRABATI, A. K. (1999) Speeding Up the Pace of New Product Development. *Journal of Product Innovation Management,* 16**,** 231-247.

KONERS, U. & GOFFIN, K. (2007) Managers' perceptions of learning in new product development. *International Journal of Operations & Production Management,* 27**,** 20.

LAFORET, S. & TANN, J. (2006) Innovative characteristics of small manufacturing firms. *Journal of Small Business and Enterprise Development,* 13**,** 363.

LANDER, L., MATHESON, D., MENKE, M. M. & RANSLEY, D. L. (1995) Improving the R&D decision process. *Research Technology Management,* 38**,** 40.

LANDY, F. J. & FARR, J. L. (1983) *The Measurement of Work Performance,* London, Academic Press Inc.

LEDWITH, A., RICHARDSON, I. & SHEAHAN, A. (2006) Small firm-large firm experiences in managing NPD projects. *Journal of Small Business and Enterprise Development,* 13**,** 425.

LERNER, A. W. & WANAT, J. (1983) Fuzziness and Bureaucracy. *Public Administration Review,* 43**,** 10.

LESEURE, M. J. (2000) Manufacturing strategies in the hand tool industry. *International Journal of Operations and Production Management,* 20**,** 1475-87.

LEVINE, D. M., BERENSON, M. L. & STEPHAN, D. (1998) *Statistics for Managers Using Microsoft Excel,* Upper Saddle River, NJ, Prentice Hall.

LINDMAN, M. T. (2002) Open or closed strategy in developing new products? A case study of industrial NPD in SMEs. *European Journal of Innovation Management,* 5**,** 224.

LOCH, C., STEIN, L. & TERWIESCH, C. (1996) Measuring development performance in the electronics industry. *The Journal of Product Innovation Management,* 13**,** 3.

LOCKAMY, A. & COX, J. F. (1994) *Reengineering Performance Measurement,* Burr Ridge, Illinois, Richard D. Irwin, Inc.

LYNN, G. (1998) New Product Team Learning: Developing and Profiting from your Knowledge Capital. *California Management Review,* 40**,** 74-93.

LYNN, G., MAZZUCA, M., MORONE, J. G. & PAULSON, A. S. (1998) Learning Is the Critical Success Factor in Developing Truly New Products. *Research Technology Management,* 41**,** 45-51.

LYNN, G., S. & REILLY, R., R. (2000) Measuring team performance. *Research Technology Management,* 43**,** 9.

LYNN, G., SKOV, R. B. & ABEL, K. D. (1999) Practices that Support Team Learning and Their Impact on Speed to Market and New Product Success. *Journal of Product Innovation Management***,** 439-454.

MAHAJAN, V. & WIND, J. (1992) New Product Models: Practice, Shortcomings and Desired Improvements. *Journal of Product Innovation Management,* 9**,** 128-139.

MATTHEWS, M. (2007) Capability building and risk management: Lessons from Radiata. *Innovation : Management, Policy & Practice,* 9**,** 170.

MILES, M. B. & HUBERMAN, A. M. (1984) *Qualitative Data Analysis: A sourcebookof new methods,* London, Sage Publications.

MILES, R. E. & SNOW, C. C. (1978) *Organisational Strategy, Structure, and Process,* New York, McGraw-Hill.

MONTOYA-WEISS, M. & CALANTONE, R. (1994) Determinants of New Product Performance: A Review and Meta-Analysis. *Journal of Product Innovation Management,* 11**,** 397-417.

MOTWANI, J. (2001) Critical factors and performance measures of TQM. *The TQM Magazine,* 13**,** 9.

NANNI, A. J., JR., DIXON, J. R. & VOLLMANN, T. E. (1992) Integrated Performance Measurement: Management Accounting to Support the New Manufacturing Realities. *Journal of Management Accounting Research,* 4**,** 1.

NEELY, A., FILIPPINI, R., FORZA, C., ANDREA, V. & HII, J. (2001) A framework for analysing business performance, firm innovation and related contextual factors: perceptions of managers and policy makers in two European regions. *Integrated Manufacturing Systems,* 12**,** 114-124.

NEELY, A., GREGORY, M. & PLATTS, K. (1995) Performance Measurement System Design: A Literature Review and Research Agenda. *International Journal of Operations and Production Management,* 15**,** 80-116.

NEELY, A., RICHARDS, H., MILLS, J., PLATTS, K. & BOURNE, M. (1997) Designing Performance Measures: a structured approach. *International Journal of Operations and Production Management,* 17**,** 1131-1152.

NEUMAN, W. L. (2006) *Social Research Methods: qualitative and quantitative approaches,* Boston, Pearson/Allyn and Bacon.

NONAKA, I. (1991) The Knowledge-Creating Company. *Harvard Business Review,* 69**,** 9.

OECD-EUROSTAT (1997) The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological data. *Oslo Manual.* Paris, OECD.

O'MARA, C. E. (1996) An examination of the linkages between organisational performance measures and strategic objectives. *Faculty of Business and Technology.* Sydney, University of Western Sydney.

O'REGAN, N., GHOBADIAN, A. & GALLEAR, D. (2006) In search of the drivers of high growth in manufacturing SMEs. *Technovation,* 26**,** 30.

O'SHEA, A. & MCBAIN, N. (1999) The process of innovation in small manufacturing firms. *International Journal of Technology Management,* 18**,** 610.

OSHRI, I., PAN, S., L. & NEWELL, S. (2006) Managing Trade-offs and Tensions between Knowledge Management Initiatives and Expertise Development Practices. *Management Learning,* 37**,** 20.

PAGE, A. L. (1993) Assessing New Product Development Practices and Performance: Establishing Crucial Norms. *Journal of Product Innovation Management,* 10**,** 273-290.

PARK, R. E., GOETHERT, W. B. & FLORAC, W. A. (1996) *Goal Driven Software Measurement - A Guidebook,* Pittsburgh, PA., Software Engineering Institute, Carnegie Mellon University.

PATTERSON, W. C. (1983) Evaluating R&D Performance at the Alcoa Laboratories. *Research Management*.

PORTER, M. E. (1985) *Competitive Advantage: creating and sustaining superior performance,* New York, Free Press.

PRAHALAD, C. K. & HAMEL, G. (1990) The Core Competence of the Corporation. *Harvard Business Review,* 68**,** 13.

PRITCHARD, R. D. (1990) *Measuring and Improving organisational productivity; a practical guide,* New York, NY., Praeger Publishers.

PUNCH, K. F. (1998) *Introduction to Social Research: Quantitative and Qualitative Approaches,* London, Sage Publications.

RAYMOND, L. & ST-PIERRE, J. (2004) Customer dependency in manufacturing SMEs: implications for R&D and performance. *Journal of Small Business and Enterprise Development,* 11**,** 23.

RICHARDSON, P. R. & GORDON, J. R. M. (1980) Measuring Total Manufacturing Performance. *Sloan Management Review***,** 47-58.

ROBB, W. L. (1991) How good is our research? *Research Technology Management,* 34**,** 16-21.

ROGERS, E. & SHOEMAKER, R. (1971) *Communications of Innovations: a cross-cultural approach,* New York, Free Press.

ROSCOE, J. T. (1975) *Fundamental Research Statistics for the Behavioural Sciences,* New York, Holt, Rinehart and Winston.

ROSENAU, M. D. (1988) Faster New Product Development. *Journal of Product Innovation Management***,** 150-163.

ROTHWELL, R. & ZEGVELD, W. (1985) *Reindustrialisation and Technology,* London, Longman.

ROUSSEL, P. A., SAAD, K. N. & ERICKSON, T. J. (1991) *Third Generation R&D: managing the link to corporate strategy,* Boston, Harvard Business School Press.

SANDERSON, S. & UZUMERI, M. (1995) Managing product families: The case of the Sony Walkman. *Research Policy,* 24**,** 761.

SAREN, M. A. (1984) A classification and review of models of the intra-firm innovation process. *R&D Management,* 14**,** 11-24.

SCHILLING, M., A. & HILL, C., W. L. (1998) Managing the new product development process: Strategic imperatives. *The Academy of Management Executive,* 12**,** 15.

SCHOLTES, P. R. (1992) *The Team Handbook,* Madison, WI., Joiner Associates.

SCOZZI, B., GARAVELLI, C. & CROWSTON, K. (2005) Methods for modelling and supporting innovation processes in SMEs. *European Journal of Innovation Management,* 8**,** 120.

SERWER, A. E. (1994) How to Escape a Price War. *Fortune***,** 82-88.

SHEWHART, W. A. (1931) *The Economic Control of Quality of Manufactured Product,* New York, D. Van Nostrand Company.

SLACK, N. (1994) The importance-performance matrix as a determinant of improvement priority. *International Journal of Operations & Production Management,* 14.

STARCHER, R. (1992) Mismatched Management Techniques. *Quality Progress,* 25**,** 4.

STATA, R. (1989) Organizational Learning - The Key to Management Innovation. *Sloan Management Review,* 30**,** 12.

THOMKE, S. & FUJIMOTO, T. (2000) The Effect of "Front-Loading" Problem Solving on Product Development Performance. *Journal of Product Innovation Management,* 17**,** 128-142.

TIDD, J., BESSANT, J. & PAVITT, K. L. R. (1997) *Managing Innovation: Integrating technological, market and organizational change,* Chichester, John Wiley.

TOMKOVICK, C. & MILLER, C. (2000) Perspective - Riding the Wind: Managing New Product Development in an Age of Change. *Journal of Product Innovation Management,* 17**,** 413-423.

TROTT, P. (2005) *Innovation Management and New Product Development,* London, Pearson Education Ltd.

TUSHMAN, M. L. & O'REILLY, C. A. (1997) *Winning through Innovation,* Boston, Mass., Harvard Business School Press.

ULRICH, K. T. & EPPINGER, S. D. (2000) *Product Design and Development,* Boston, Irwin McGraw-Hill.

VON HIPPEL, E. (1978) Users as Innovators. *Technology Review,* 80**,** 5.

VON HIPPEL, E. (1986) LEAD USERS: A SOURCE OF NOVEL PRODUCT CONCEPTS. *Management Science (1986-1998),* 32**,** 15.

VOSS, C., COUGHLAN, P. & CHIESA, V. (1994) Innovation - Your Move. IN INDUSTRY, D. O. T. A. (Ed. London, March Consulting Group.

VOSS, C., COUGHLAN, P., CHIESA, V. & FAIRHEAD, J. (1992) *Scoresheets for Quantifying Performance in Managing Innovation,* London, London Business School.

WALSH, P. & SINCLAIR, D. (1995) Improving Business Performance: Drivers versus Outcomes. *The Quality Magazine,* 4**,** 6.

WALSH, P. (1995) Performance Measurement: A New Paradigm. *Director's Forum,* 11**,** 5.

WERNER, B. M. & SOUDER, W. E. (1997) R&D Performance Measurement: a state of the art review. *Research Technology Management,* 40**,** 34-42.

WHEELWRIGHT, S. C. & CLARK, K. B. (1992a) Creating Project Plans to Focus Product Development. *Harvard Business Review***,** 70-82.

WHEELWRIGHT, S. C. & CLARK, K. B. (1992b) *Revolutionizing product development: quantum leaps in speed, efficiency, and quality,* New York, Free Press.

WOODCOCK, D. J., MOSEY, S. P. & WOOD, T. B. W. (2000) New product development in British SMEs. *European Journal of Innovation Management,* 3**,** 212.

WYNARCZYK, P. (1997) The Economic Success of UK Innovative Small Firms. *42nd World Conference of International Council for Small Business.* San Francisco.

YIN, R. K. (1994) *Case Study Research Design and Methods,* London, Sage Publications.

YOUNG, S. (1993) Management: Checking performance with competitive benchmarking. *Professional Engineering,* 6**,** 2.

ZEITZ, G., JOHANNESSON, R. & RITCHIE, J. E. J. (1997) An employee survey measuring total quality management practices and culture: Development and validation. *Group & Organization Management,* 22**,** 31.

Appendices

Appendix 1: Business Unit Quantitative Survey

INDUSTRIAL PRACTICES AND PERFORMANCE PRESENT AND FUTURE IN NEW PRODUCT DEVELOPMENT

General instructions and information

The purpose of this survey is to understand how industrial companies are performing and which practices they use and intend to implement in the near future, in order to attain and improve this performance.

The survey is organised into the following sections:

I. *Your business unit profile* in terms of strategy, products and markets, competitive environment, and performance. *Group profile* positioning your business unit

IIA *New Product Development practices and performances*.

This is Section I of the questionnaire. Some of your colleagues may complete the other section. Please answer **all** the questions by filling in the blanks as indicated or ticking/circling the most appropriate response, or with "n/a" (not applicable) if the question does not apply.

Please note that your responses will be treated with absolute confidentiality. None of the information you submit will be identified with you or your company.

If you have questions regarding the questionnaire, please contact:
Charles O'Mara phone: 02 4620 3024 e-mail: e.omara@uws.edu.au

Please return the completed survey as an email attachment, or if you prefer, in hard copy to:

Charles O'Mara
University of Western Sydney
Building 11, Campbelltown Campus
Locked Bag 1797
PENRITH SOUTH DC NSW 1797
AUSTRALIA

Section I Business Unit Profile Page 1 of 11

Business unit - An organisational entity serving a distinct product-market combination by performing all or most of the activities aimed at developing, producing and marketing a discrete collection of products and/or services that are related to one another. A company (or group of companies) may consist of different business units, each responsible for serving a distinct product-market combination. A business unit may comprise various sites but it is also possible that one location hosts several business units.

SECTION I: BUSINESS UNIT AND GROUP PROFILE, PRACTICES AND PERFORMANCE

The aim of this section is to map the context of the new product development, operations and supply chain management processes of the business unit ° in which you are positioned. The questions are concerned with the strategy, market and competition, general management issues and overall organisation of your business unit.

General information on the business unit

1.1. What is the name of your business unit? _____

1.2. Where is your business unit located? _____

1.3. When was your business unit established in its current form and with its current mission (year)? _____

The business unit's competitive strategy

1.4. How important is the role of the following objectives in your business unit's strategy? Please rank the three currently most important objectives in descending order of importance with 1 indicating most important and 3 indicating least important. Please indicate for each of the top-three plus other relevant objectives if their importance has changed over the last three years, and also if you expect their importance to change over the next three years.

Objectives	Rank	Over the last three years the importance of the objective has become less important	stayed the same	become more important	Over the next three years the importance of the objective will become less important	stay the same	become more important	We don't know
Employment	____	❑	❑	❑	❑	❑	❑	❑
Green production	____	❑	❑	❑	❑	❑	❑	❑
Growth (turnover)		❑	❑	❑	❑	❑	❑	❑
Innovation		❑	❑	❑	❑	❑	❑	❑
Market share	____	❑	❑	❑	❑	❑	❑	❑
Profitability	____	❑	❑	❑	❑	❑	❑	❑
Reputation	____	❑	❑	❑	❑	❑	❑	❑
Survival	____	❑	❑	❑	❑	❑	❑	❑
Others, namely: _____	____	❑	❑	❑	❑	❑	❑	❑

1.5. Please rate the following competitive methods based on how important they are in pursuing your business unit's competitive strategy. If necessary, you may answer this question focusing on your business unit's most important product line.

	Not important			Important			Critically important	Not applicable
A high level of customer service	1	2	3	4	5	6	7	❑
Operating efficiency	1	2	3	4	5	6	7	❑
Product quality control	1	2	3	4	5	6	7	❑
Experienced/trained personnel	1	2	3	4	5	6	7	❑
Developing new products/services	1	2	3	4	5	6	7	❑
Refining/improving existing products/services	1	2	3	4	5	6	7	❑
Procurement of raw materials	1	2	3	4	5	6	7	❑
Minimising use of outside financing	1	2	3	4	5	6	7	❑
Innovation in manufacturing processes	1	2	3	4	5	6	7	❑
Competitive pricing	1	2	3	4	5	6	7	❑
Broad range of products	1	2	3	4	5	6	7	❑
Serving special geographical markets	1	2	3	4	5	6	7	❑

Please continue question 1.5 on page 3

Question 1.5 continued	Not important			Important			Critically important	Not applicable
Capability to manufacture specialty products	1	2	3	4	5	6	7	❑
Products in high price market segments	1	2	3	4	5	6	7	❑
Maintaining high inventory levels	1	2	3	4	5	6	7	❑
Brand identification	1	2	3	4	5	6	7	❑
Innovation in marketing techniques and methods	1	2	3	4	5	6	7	❑
Control of distribution channels	1	2	3	4	5	6	7	❑
Rapid delivery speed	1	2	3	4	5	6	7	❑
Dependable delivery	1	2	3	4	5	6	7	❑
Extensive use of advertising	1	2	3	4	5	6	7	❑
Forecasting market growth	1	2	3	4	5	6	7	❑
Others, namely: _____	1	2	3	4	5	6	7	❑

1.6. Who influences decisions on which strategic priorities your business unit will pursue, and to what extent? Please circle one item on each line.

	No influence			Decisive influence	Not applicable
Owners/shareholders	1	2	3	4	❑
Group board of directors	1	2	3	4	❑
Group management team	1	2	3	4	❑
Business unit management team	1	2	3	4	❑
Marketing/sales manager	1	2	3	4	❑
R&D/new product development manager	1	2	3	4	❑
Production manager	1	2	3	4	❑
Other functional manager(s), namely: _____	1	2	3	4	❑
Employees	1	2	3	4	❑
Trade unions/works council	1	2	3	4	❑
Customers	1	2	3	4	❑
Suppliers	1	2	3	4	❑
Other(s), namely: _____	1	2	3	4	❑

The business unit's market(s) and competitors

1.7. Which of the following best describes the nature of the market(s) your business unit competes in? Please circle one alternative per row.

New	1	2	3	4	Mature
Declining rapidly	1	2	3	4	Growing rapidly
Dynamic	1	2	3	4	Stable
Open to new players	1	2	3	4	Closed to new players
Many players	1	2	3	4	Niche
Hostile	1	2	3	4	Friendly
Requiring proactive behaviour	1	2	3	4	Requiring reactive behaviour

Business to business - Business conducted between companies, rather than between a company and individual consumers.

Business to consumer - Business conducted between a company and individual consumers (or intermediary companies - like stores, supermarket chains or wholesalers, serving individual consumers).

Consumers - Individuals who buy goods or services for personal use and not for manufacture or resale.

Return on sales (ROS) – Profit before interests and taxes as a percentage of sales.

Return on investment (ROI) – Profit before interests and taxes as a percentage of total assets. ROI may not be applicable for co-operatives (andelsselskaber).

1.8. Which of the following best describes your business unit? Please tick one alternative per row, if applicable.

Our business unit's	in a limited part of a single country	throughout one single country	in a few countries on a single continent	in a few countries on different continents	globally, in many countries on all continents
products are sold	❑	❑	❑	❑	❑
materials/components are sourced	❑	❑	❑	❑	❑
subassemblies/modules are sourced	❑	❑	❑	❑	❑
employees are recruited	❑	❑	❑	❑	❑

1.9. What percentage of sales does your business unit generate in business-to-business and business-to-consumer markets, respectively °? Please note that the sum-total should be 100%.

Business to business _____ % of sales Business to consumer _____ % of sales

Business unit performance

1.10. What is the current commercial performance of your business unit on the following dimensions? How does your business unit perform compared to three years ago?

	Current figure (2001)	In the last three years the performance has increased	stayed the same	decreased
Sales	_____ DKK	❑	❑	❑
Sales to export	_____ %	❑	❑	❑
Return on sales (ROS) °	_____ %	❑	❑	❑
Return on investment (ROI) °	_____ %	❑	❑	❑

1.11. How does your business unit perform on the following dimensions, relative to your own targets and relative to your main competitor?

	Relative to our own targets we perform much better		**achieve our target**		perform much worse	Relative to our main competitor, our performance is much better		**equal**		**much worse**	We don't know
Sales	1	2	3	4	5	1	2	3	4	5	❑
Sales to export	1	2	3	4	5	1	2	3	4	5	❑
Return on sales (ROS) °	1	2	3	4	5	1	2	3	4	5	❑
Return on investment (ROI) °	1	2	3	4	5	1	2	3	4	5	❑

The business unit's products

1.12. How would you describe your business unit's product mix? Please tick one.

❑ High volume/high mix ❑ High volume/low mix
❑ Low volume/high mix ❑ Low volume/low mix

1.13. Please characterise your business unit's product portfolio on the following characteristics.

Innovative	1	2	3	4	Not innovative
Complex	1	2	3	4	Simple
Customised	1	2	3	4	Standard

Action programme – a major project aimed at producing considerable changes in your business unit's management practices and organisation, to which your business unit is devoting substantial resource and innovation effort, and on which is concentrated significant management focus and commitment.

Benefit – improved performance.

Improved co-ordination and collaboration – By, for example, implementing self-managing/empowered work teams, cross-functional collaboration, new or simpler administrative routines.

Employee development –By, for example, making the workforce more flexible, multi-skilled, increasing delegation and empowerment; improving employee commitment and attitude towards change.

TQM – Total Quality Management.

QFD – Quality Function Deployment (House of Quality).

EFQM – European Foundation for Quality Management.

ABC costing – Activity Based Costing.

E-commerce, e-business – Use of the Internet to support marketing and sales activities.

Company – Independent legal entity, usually with one or a few sites, with all business functions represented at that or the main site.

Division – A plant or a group of plants with a central headquarters, producing either similar products (e.g. chips), or for similar market segments (e.g. domestic appliances) or serving one or a few geographical areas (e.g. North and South America). There is usually more than one division in a group.

Plant – Production (manufacturing and/or assembly) facility with no or limited new product development, marketing and sales activities; part of a (division of a) group.

Business unit action programmes

1.14. This question explores ongoing and intended general action programmes °. On the far-left side, please indicate the extent to which the programme has been undertaken within the last three years. On the second left-hand scale, indicate the relative benefit ° from the programme. On the right-hand scale, indicate whether there are plans and budgeted activities to undertake the programme within the coming three years.

Degree of effort last 3 years (none – high)	Benefit (low – high)	Implementation of	Expected emphasis next 3 years (none – high)	We don't know
1 2 3 4 5	1 2 3 4 5	Formal continuous improvement (CI) programme	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Total Productive Maintenance (TPM)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Supply Chain Management (SCM)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Customer Relationship Management (CRM)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Improved co-ordination and collaboration °	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Employee development °	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Enterprise Resource Planning Systems (ERP)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Quality management (e.g. TQM °, QFD °, ISO 9000)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Business Excellence (EFQM °)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Balanced Scorecard (BSC)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Formal strategic management process	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	New accounting approaches (e.g. ABC costing °)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Business Process Redesign (BPR)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	E-commerce or e-business °	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Benchmarking other companies' practices and performance	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Others, namely _____	1 2 3 4 5	❑

The business unit's organisation and personnel

1.15. Which functions are present at your business unit's location? Please tick all appropriate alternatives.

❑ New Product Development ❑ Production ❑ Logistics ❑ Marketing & Sales ❑ Corporate Headquarters

1.16. What is the annual budget, as a percentage of sales, for training your business unit's personnel?

____ % ❑ We don't budget this

1.17. What is the number of employees in your business unit (in fte = full time equivalents)?

Three years ago _____ fte
At present _____ fte
Expected in three years time _____ fte ❑ We don't know

Group profile

1.18. Please indicate what best describes your business unit.

❑ Company ° ❑ Division ° ❑ Plant ° ❑ Other, namely _____

1.19. Is your business unit part of a group? ❑ Yes ❑ No

If yes, the business unit is: ❑ The parent company ❑ A subsidiary

If a subsidiary, the parent is from: ❑ The same country ❑ Europe ❑ North America ❑ South America ❑ Asia ❑ Australia ❑ Other (please specify) _____

1.20. How is your business unit or, if it is a subsidiary in a group, the parent company held? Please tick one.

❑ Public ownership ❑ Institutional ownership ❑ Private ownership ❑ Co-operative

If publicly held, is your company quoted on the stock exchange? ❑ Yes ❑ No

1.21. Please tick the alternative that best describes the group's situation.

	At one site in the group's home country	At more than one site in the group's home country	At sites in a few countries on a single continent	At sites in a few countries on different continents	Globally, at sites in many countries on all continents
Where are the group's products produced?	❑	❑	❑	❑	❑
do the group's product development activities generally take place?	❑	❑	❑	❑	❑

Feedback

1.22. We will develop a feedback report to all respondents. Please help us preparing that by indicating the type and form of feedback you would prefer. Therefore please tick the alternative(s) that best fulfil(s) your need.

	Basic statistics	Fact book on general observations & comments	Individual prepared & paid for feed-back report with data and comments
Available from Internet	❑	❑	
CD-Rom	❑	❑	
Paper version	❑	❑	❑

1.23 What kind of feedback would you like us to provide you with?

	On business unit level and for all three functional areas (NPD, operations, SCM)	On business unit level only	For NPD only	For operations only	For SCM only
Strategy and performance comparison with					
• similar companies.	❑	❑	❑	❑	❑
• other industries.	❑	❑	❑	❑	❑
Comparison with the practices of					
• similar companies.	❑	❑	❑	❑	❑
• other industries.	❑	❑	❑	❑	❑
Comparison with the action plans of					
• similar companies.	❑	❑	❑	❑	❑
• other industries.	❑	❑	❑	❑	❑

(An)other kind(s) of feedback, namely _____

_____

_____

OPEN COMMENTS

Please outline here your opinions, either on aspects not covered in this questionnaire, or on the questionnaire itself, and/or issues of importance for your own industrial sector.

CONTACT INFORMATION OF THE RESPONDENT

Name _____ Title _____

Job position _____

Business unit _____

Street _____

Postal code and city _____

Phone _____ Fax _____ E-mail _____

I have been with this business unit for _____ years, and in my current position for _____ years.

Thank you for completing the questionnaire. Please note, again, that your answers will be treated with full confidentiality. The names of companies, business units, products or individuals will not be released!

Appendix 2: New Product Development Unit Quantitative Survey

INDUSTRIAL PRACTICES AND PERFORMANCE PRESENT AND FUTURE IN NEW PRODUCT DEVELOPMENT

General instructions and information

The purpose of this survey is to understand how industrial companies are performing and which practices they use and intend to implement in the near future, in order to attain and improve this performance.

The survey is organised into the following sections:

I. *Your business unit profile* in terms of strategy, products and markets, competitive environment, and performance. *Group profile* positioning your business unit

IIA *New Product Development practices and performances*.

This is Section IIA of the questionnaire. Some of your colleagues may complete the other sections. Please answer **all** the questions by filling in the blanks as indicated or ticking/circling the most appropriate response, or with "n/a" (not applicable) if the question does not apply.

Please note that your responses will be treated with absolute confidentiality. None of the information you submit will be identified with you or your company.

If you have questions regarding the questionnaire, please contact:
Charles O'Mara phone: 02 4620 3024 e-mail: e.omara@uws.edu.au

Please return the completed survey as an email attachment, or if you prefer, in hard copy to:

Charles O'Mara
University of Western Sydney
Building 11, Campbelltown Campus
Locked Bag 1797
PENRITH SOUTH DC NSW 1797
AUSTRALIA

SECTION II: BUSINESS UNIT PRACTICES AND PERFORMANCE

In this section you and some of your colleagues are asked a range of questions on your business unit's practices and performance in the areas of new product development. The answers to these questions will allow us:

- To identify how Australian companies are performing and which practices they use and intend to implement in the near future, in order to attain and improve this performance.
- To generate a feedback report to you in which your business unit is benchmarked against other companies in your industry and in other industries.

Product price - Off-the-shelf price but also including e.g. life cycle cost.

Product functionality - The extent to which the product meets the customer's functional specifications/expectations.

Conformance quality - The extent to which the product meets the customer's technical specifications/expectations.

Time-to-market - The time between starting the development of a new product and its launch in the market place.

Product design/innovation - E.g. the looks, feel, styling of the product, but also technological advance.

Product customisation - Adapting existing products to specific customer requirements.

Product range - The portfolio of products offered to the market place.

Environmentally sound products - E.g. the extent to which the product is recyclable, components can be reused, or biodegradable materials are used.

SECTION IIA: New product development (NPD) practices and performance

NPD strategy

2.1 How important is the role of the following competitive priorities in your business unit's NPD strategy? Please rank the current priorities in descending order of importance with 1 indicating most important. Put 'n/a' behind priorities that do not currently play a role. Please indicate for each of the indicators if their priority has changed over the last three years, and also if you expect their importance to change over the next three years. Please bear in mind that currently irrelevant competitive priorities may have been or may become important in the past or the future, respectively.

	Rank	Over the last three years the competitive priority has			Over the next three years the competitive priority will			
		become less important	stayed the same	become more important	become less important	stay the same	become more important	We don't know
Product price °	____	❑	❑	❑	❑	❑	❑	❑
Product functionality °	____	❑	❑	❑	❑	❑	❑	❑
Conformance quality °	____	❑	❑	❑	❑	❑	❑	❑
Time-to-market for new products °	____	❑	❑	❑	❑	❑	❑	❑
Product design/innovation °	____	❑	❑	❑	❑	❑	❑	❑
Product customisation °	____	❑	❑	❑	❑	❑	❑	❑
Product range °	____	❑	❑	❑	❑	❑	❑	❑
Company reputation	____	❑	❑	❑	❑	❑	❑	❑
Environmentally sound products °	____	❑	❑	❑	❑	❑	❑	❑
Others, namely: _____	____	❑	❑	❑	❑	❑	❑	❑

2.2 Please indicate the extent to which your business unit's NPD strategy is driven by:

	Not at all			Entirely
Corporate strategy (if applicable)	1	2	3	4
Business unit competitive strategy	1	2	3	4
Customer/market demands	1	2	3	4
Supplier initiatives	1	2	3	4
Competitors' NPD performance	1	2	3	4
Technological developments	1	2	3	4
Other(s), namely:_____	1	2	3	4

NPD performance

2.3 How do you rate the innovativeness of your business unit (please tick the most appropriate alternative on each line)?

Our business unit is best characterised as:

❑ Innovative	❑ A fast follower	❑ A late follower	❑ Not innovative
❑ Mostly oriented to product innovation	❑ More product innovation than production oriented	❑ More production than product innovation oriented	❑ Mostly production oriented
❑ The most innovative business unit in our industry	❑ One of the more innovative business units in our industry	❑ One of the less innovative business units in our industry	❑ The least innovative business unit in our industry

NPD project lead-time – Time between start and finish (hand-over to production) of NPD projects.
True innovations – Products new to your business unit and the world.
New product lines – Products new to your business unit, allowing access to new markets.
Product line extensions - Products new to your business unit but part of an existing family.
Improved products – Products improved/modified to offer improved performance to customers within the last three years.

Capacity utilisation – Used labour capacity (in full-time equivalents) for successfully completed projects as a percentage of total available capacity.

Direct and indirect NPD cost – Direct costs such as labour and also consumables that are directly linked with NPD an NPD project. Indirect costs include e.g. management and support staff, office space, and other costs that cannot be directly linked to a single NPD project. Please note that the sum total of direct and indirect cost should be 100%.

Innovativeness – The ability to efficiently and quickly develop and successfully launch new, affordable and high-quality products.

Customisation capability – The ability to efficiently and quickly develop and deliver customer specific variations on existing products.

2.4 Please tick which of the following NPD performance dimensions are quantitatively measured or qualitatively assessed and then indicate their current levels. Please do so for all performance dimensions for which you can provide a figure or an assessment, even if the performance dimension is not formally measured/assessed.

Performance dimension	We measure/ assess the performance dimension	Current performance
Average NPD project lead-time °		
• True innovations °	❑	____ months
• New product lines °	❑	____ months
• Product line extensions °	❑	____ months
• Product improvements/modifications °	❑	____ weeks
Percentage of projects over-running planned project lead time	❑	
Average time-to-market, from concept to launch		
• True innovations °	❑	____ months
• New product lines °	❑	____ months
• Product line extensions °	❑	____ months
• Product improvements/modifications °	❑	____ weeks
Percentage of projects over-running planned time-to-market	❑	____ %
Value added time (real development time as a percentage of lead-time)	❑	____ %
Percentage of projects over-running budget	❑	____ %
Annual value added (total NPD cost as a percentage of sales)	❑	____ %
Capacity utilisation °	❑	____ %
Average number of new product ideas evaluated per year during the last ____ years	❑	____ ideas
Percentage of sales from new products introduced during the last ____ years	❑	____ %
Market share of new products after ____ year(s)	❑	____ %
Direct NPD costs per year °	❑	_____ A$
Indirect NPD costs per year °	❑	_____ A$
Average number of engineering design changes, per NPD project, initiated by		
• Suppliers	❑	____ changes
• Production	❑	____ changes
• Customers	❑	____ changes
Number of NPD projects successfully completed as a percentage of projects started	❑	____ %
Number of projects the business unit is engaged in at any one time		
• True innovations °	❑	____ projects
• New product lines °	❑	____ projects
• Product line extensions °	❑	____ projects
• Product improvements/modifications °	❑	____ projects

	We measure/ assess the performance dimension	Current performance		
		high	medium	low
The innovativeness ° of the NPD function	❑	❑	❑	❑
The NPD function's product customisation capability °	❑	❑	❑	❑
Reputation of the NPD function with customers/competitors	❑	❑	❑	❑

NPD project lead-time – Time between start and finish (hand-over to production) of NPD projects.
True innovations – Products new to your business unit and the world.
New product lines – Products new to your business unit, allowing access to new markets.
Product line extensions - Products new to your business unit but part of an existing family.
Improved products – Products improved/modified to offer improved performance to customers within the last three years.

Time-to-market – The time between starting the development of a new product and its launch in the market place.

Capacity utilisation – Used labour capacity (in full-time equivalents) for successfully completed projects as a percentage of total available capacity.

Direct and indirect NPD cost – Direct costs such as labour and also consumables that are directly linked with NPD an NPD project. Indirect costs include e.g. management and support staff, office space, and other costs that cannot be directly linked to a single NPD project. Please note that the sum total of direct and indirect cost should be 100%.

Product functionality – The extent to which the product meets the customer's functional specifications/expectations.
Conformance quality – The extent to which the product meets the customer's technical specifications/expectations.

Manufacturability/assemblability – The relative ease with which parts and components can be produced and assembled to complete products.

Level of modularisation – The extent to which parts, components and modules are used in different products.

Innovativeness – The ability to efficiently and quickly develop and successfully launch new, affordable and high-quality products.

Product Platform – Product families that share similarities in design, development, or production process.

Customisation capability – The ability to efficiently and quickly develop and deliver customer specific variations on existing products.

2.5 Please indicate for each performance dimension how your business unit's NPD function performance has changed over the last three years. Please focus your answers on the performance dimensions that you do measure/assess and/or for which you could provide a figure/indication in the previous question. Then, please tick if you measure or assess your main competitors' performance and finally indicate how your business unit's current performance compares with your main competitors' NPD performance.

	Our business unit's NPD performance					Our main competitors' NPD performance					
	Compared to three years ago our performance has					We measure/assess the competitors' performance	Compared to our main competitors our performance is				
	decreased more than 20%		stayed the same		increased more than 20%		much better		the same		much worse
Average NPD project lead-time °	1	2	3	4	5	❑	1	2	3	4	5
Percentage of projects over-running planned project lead time	1	2	3	4	5	❑	1	2	3	4	5
Average time-to-market °	1	2	3	4	5	❑	1	2	3	4	5
Percentage of projects over-running planned time-to-market	1	2	3	4	5	❑	1	2	3	4	5
Percentage of projects over-running budget											
Direct NPD cost °	1	2	3	4	5	❑	1	2	3	4	5
Indirect NPD cost °	1	2	3	4	5	❑	1	2	3	4	5
Number of engineering design changes	1	2	3	4	5	❑	1	2	3	4	5
	increased more than 20%		stayed the same		decreased more than 20%						
Value added time	1	2	3	4	5	❑	1	2	3	4	5
Annual value added	1	2	3	4	5	❑	1	2	3	4	5
Capacity utilisation °	1	2	3	4	5	❑	1	2	3	4	5
Number of new product ideas evaluated	1	2	3	4	5	❑	1	2	3	4	5
Percentage of sales from new products	1	2	3	4	5	❑	1	2	3	4	5
Market share of new products	1	2	3	4	5	❑	1	2	3	4	5
Percentage of NPD projects completed successfully	1	2	3	4	5	❑	1	2	3	4	5
Number of projects the business unit is engaged in at any one time	1	2	3	4	5	❑	1	2	3	4	5
	strongly improved		stayed the same		strongly deteriorated						
Product functionality °	1	2	3	4	5	❑	1	2	3	4	5
Conformance quality °	1	2	3	4	5	❑	1	2	3	4	5
Production cost of new products	1	2	3	4	5	❑	1	2	3	4	5
Manufacturability/assemblability of new products °	1	2	3	4	5	❑	1	2	3	4	5
Level of modularisation of new products °	1	2	3	4	5	❑	1	2	3	4	5
Extent to which new product designs are based on (a) common platform(s) °	1	2	3	4	5	❑	1	2	3	4	5
Innovativeness of the NPD function °	1	2	3	4	5	❑	1	2	3	4	5
Product customisation capability °	1	2	3	4	5	❑	1	2	3	4	5
Reputation of the NPD function	1	2	3	4	5	❑	1	2	3	4	5
Environmentally sound products	1	2	3	4	5	❑	1	2	3	4	5

2.6 a. What is your business unit's annual NPD budget as a percentage of sales? ____ %

b. This is ❑ lower than, ❑ similar to, ❑ higher than what is normal in our industry.

❑ We don't know how our NPD budget compares to industry.

Action programme – A major project aimed at producing considerable changes in your business unit's management practices and organisation, to which your business unit is devoting substantial resource and innovation effort, and on which is concentrated significant management focus and commitment.

Benefit – Improved performance.

Cross-functional teams – Teams of employees representing different functional disciplines and/or different process segments who tackle a specific problem or perform a specific task, frequently or on an ad hoc basis.

CAD - Computer Aided Design; **CAM** - Computer Aided Manufacturing; **CAE** - Computer Aided Engineering

FMEA - Failure Mode and Effect Analysis; **QFD** - Quality Function Deployment

Concurrent Engineering – A cross-functional, team-based approach in which the product and the manufacturing/ assembly process are designed and configured within the same time frame, rather than sequentially. Ease and cost of manufacturing and assembly, as well as customer needs, quality issues and product-life-cycle costs are taken into account early in the development cycle. Fully configured concurrent engineering teams include representation from marketing, design engineering, manufacturing engineering, and purchasing, and possibly also suppliers and/or customers.

NPD action programmes

2.7 This question explores your business unit's NPD action programmes °. On the far-left side, indicate the extent to which the programme has been undertaken within the last three years. On the second left-hand scale, indicate the relative benefit from the activity. On the right-hand scale, indicate whether there are plans and budgeted activities to undertake the programme within the coming three years.

Degree of effort last 3 years (none – high)	Benefit (low – high)	Action programme	Expected emphasis next 3 years (none – high)	We don't know
1 2 3 4 5	1 2 3 4 5	Formal continuous improvement programme	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Self-managing/empowered NPD teams	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Flexible, multi-disciplinary NPD staff	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Use of cross-functional teams °	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Administrative routines	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Employee commitment/attitude towards change	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Employee skills	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	New computer-aided design tools (e.g. CAD °, CAM °, CAE °)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	New non-computerised tools and techniques (e.g. QFD °, FMEA °)	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Customer participation in NPD	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Supplier participation in NPD	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Participation of marketing/sales in NPD	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Participation of production in NPD	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Involvement of universities and research institutes in NPD	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Concurrent Engineering °	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Benchmarking other companies' NPD practices and performance	1 2 3 4 5	❑
1 2 3 4 5	1 2 3 4 5	Formal management approaches or systems (e.g. TQM °, ISO 9000, project management)	1 2 3 4 5	❑

2.8 What is your business unit's annual budget, as a percentage of sales, for investments and actions aimed at improving NPD performance? ____ % ❑ We do not budget this

2.9 What are the main motives for the action plans aimed at improving your business unit's production performance for the next three years? Please circle one on each line.

The motive, to improve on:	Not important			Of critical importance
Cost and price targets	1	2	3	4
Design targets	1	2	3	4
Profit targets	1	2	3	4
Quality targets	1	2	3	4
Technology targets	1	2	3	4
Time targets	1	2	3	4
Market targets	1	2	3	4
Employee skills, commitment, attitude towards change	1	2	3	4
Organisation, co-operation, communication, administrative routines	1	2	3	4
Other(s), namely: _____	1	2	3	4

NPD organisation and personnel

2.10 How would you describe the way NPD projects are managed in your business unit? Please circle one.

No formal procedures 1 2 3 4 Systematically and planned

Collocation – Different disciplines involved in the NPD project are (temporarily) relocated to collaborate at the same physical location.

Labour turnover rate—A measure of a plant's ability to retain workers, expressed as a percentage of the workforce that annually departs, regardless of reason.

2.11 Which of the following best describes your business unit's product development organisation? Please tick one.

- ❑ Functional
- ❑ Project
- ❑ Matrix
- ❑ Hybrid
- ❑ Other, namely _____

2.12 Which mechanisms and tools are used to support the collaboration and communication between your business unit's NPD process and its main stakeholders (marketing, production, customers, suppliers)? Please tick all appropriate answers.

	Collaboration and communication between NPD and			
	marketing	production	customers	suppliers
Rules, standards and procedures	❑	❑	❑	❑
Collocation °	❑	❑	❑	❑
Cross-departmental team work	❑	❑	❑	❑
Cross-company team work	❑	❑	❑	❑
Job rotation	❑	❑	❑	❑
A special liaison manager	❑	❑	❑	❑
E-mail	❑	❑	❑	❑
Intranet	❑	❑	❑	❑
Video conferencing	❑	❑	❑	❑
Project meetings	❑	❑	❑	❑
Fax	❑	❑	❑	❑
Informal discussions	❑	❑	❑	❑
Design reviews	❑	❑	❑	❑
Internal post	❑	❑	❑	❑
External post	❑	❑	❑	❑
Ad-hoc	❑	❑	❑	❑

2.13 If you use (cross-functional) teams to develop new products, is there a systematically used practice to (please tick all appropriate alternatives):

- ❑ Select team leaders
- ❑ Assign tasks and responsibilities to the team leaders
- ❑ Select team members
- ❑ Assign tasks and responsibilities to the teams/team members
- ❑ Organise the collaboration within the teams
- ❑ Organise the communication/collaboration between the teams and the rest of the organisation
- ❑ Organise the communication/collaboration between the teams and higher management

2.14 Please indicate the number, in fte (= full time equivalents), of your business unit's NPD personnel.

NPD personnel	Absolute number	We don't know
Three years ago	_____ fte	
At present	_____ fte	
Expected in three years time	_____ fte	❑

2.15 a. Compared to three years ago, _____% of the current NPD personnel are new to the job, while _____% have left the NPD function for another job within or outside our business unit.

b. How does the total of these figures compare to your main competitors' NPD labour-turnover rates °?

- ❑ Higher
- ❑ The same
- ❑ Lower
- ❑ We don't know

MSc – Master of Science.
BSc – Bachelor of Science.
PhD – Doctoral degree.
MBA – Master of Business Administration.
Vocational diploma – E.g. TAFE or other Tertiary Diploma.

Support staff – The employees supporting the NPD managers and teams with planning, maintenance and quality control.

Formal training – As opposed to 'training-on-the-job', formal training provided to employees distant from the workplace, e.g. in the form of courses, workshops or seminars.

Two-digit NACE codes

15: Manufacture of food products and beverages
16: Manufacture of tobacco products
17: Manufacture of textiles
18: Manufacture of wearing apparel; dressing and dyeing of fur
19: Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20: Manufacture of wood and of products of wood and cork, except furniture
21: Manufacture of pulp, paper and paper products
22: Publishing, printing and reproduction of recorded media
23: Manufacture of coke, refined petroleum products and nuclear fuel
24: Manufacture of chemicals and chemical products
25: Manufacture of rubber and plastic products
26: Manufacture of other non-metallic mineral products
27: Manufacture of basic metals
28: Manufacture of fabricated metal products, except machinery and equipment
29: Manufacture of machinery and equipment not elsewhere classified
30: Manufacture office machinery and computers
31: Manufacture of electrical machinery and apparatus not elsewhere classified
32: Manufacture of radio, television and communication equipment
33: Manufacture of medical, precision and optical instruments
34: Manufacture of motor vehicles, trailers and semi-trailers
35: Manufacture of other transport equipment
36: Manufacture of furniture; manufacturing not elsewhere classified
45: Construction

2.16 What is the current number by level of education of your business unit's NPD personnel °?

	university + (MSc/BSc + e.g. PhD or MBA)	university (e.g. BSc or MSc)	higher vocational diploma	lower vocational diploma	secondary school
NPD manager(s)	_____	_____	_____	_____	_____
NPD team leaders	_____	_____	_____	_____	_____
NPD team members	_____	_____	_____	_____	_____
NPD support staff °	_____	_____	_____	_____	_____

2.17 The following best describes the development of the average level of education of our business unit's NPD personnel (please tick one alternative per row):

The average level of education of our business unit's NPD personnel

- ❑ is higher than three years ago ❑ is the same as three years ago ❑ is lower than three years ago
- ❑ will be higher in three years time ❑ will be the same in three years time ❑ will be lower in three years time

2.18 Per year and on average, how many hours of formal job-related training ° are given to NPD personnel? Please tick one.

Less than 8 hours	Between 8 and 20 hours	Between 21 and 40 hours	More than 40 hours
❑	❑	❑	❑

2.19 What proportion of your business unit's NPD personnel is unionised? _____ %

2.20 To what extent does your business unit use the following enablers to encourage learning and improvement in NPD?

Enablers	Not at all			In each NPD project
Policy deployment	1	2	3	4
Human resource management	1	2	3	4
Project management	1	2	3	4
Organisational arrangements	1	2	3	4
NPD tools and techniques	1	2	3	4
Management involvement	1	2	3	4
Learning climate	1	2	3	4

In order to help *you* to focus your responses on operations practices, and to help *us* to develop the right feedback, we first ask you to identify your business unit's most important product line and the industry code for this product line.

2.20a Please describe your business unit's most important product line: _____

_____

_____

2.20b What is the 2-digit NACE code ° for this product line? _____ Please refer to the Appendix if you wish to provide a more detailed, 3-digit NACE code.

OPEN COMMENTS

Please outline here your opinions, either on aspects not covered in this questionnaire, or on the questionnaire itself, and/or issues of importance for your own industrial sector.

CONTACT INFORMATION OF THE RESPONDENT

Name _____ Title _____

Job position _____

Business unit _____

Street _____

Postal code and city _____

Phone _____ Fax _____ E-mail _____

I have been with this business unit for _____ years, and in my current position for _____ years.

Thank you for completing the questionnaire. Please note, again, that your answers will be treated with full confidentiality. The names of companies, business units, products or individuals will not be released!

Appendix 3: Qualitative Survey Pro-forma

Qualitative Interview Pro-forma

New Product Development Performance in Small to Medium sized manufacturing firms.

Interview at _____ Date_____

1	Your name and job title	
2	Business unit's name	
3	Principal product	
4	What are the business unit's priorities in terms of competitive strategy?	
5	Who determines these strategic priorities?	
6	What are the business unit's priorities in terms of NPD strategy?	
7	How are these determined?	
8	How is NPD performance evaluated?	
9	Who measures NPD performance?	
10	Who monitors NPD performance?	
11	What types of action program has your organisation preferred to pursue in an effort to improve new product development performance?	
12	Based on past performance, what action programs will your firm pursue in the future?	
13	Is there any other reason that might cause your firm to choose to pursue different action programs in the future?	
14	How does your organisation evaluate the performance of its action programs?	
15	What importance does your organisation place on team-based improvement efforts?	
16	What would be the makeup of such teams?	
17	What forces drive the various action programs that your organisation has implemented?	
18	What are the most useful performance measures used by this organisation to monitor and improve NPD performance?	
19	How reliable do you consider your NPD performance measures to be?	
20	Are your NPD performance measures used in your strategic planning activities at the business unit level?	
21	Are your NPD performance measures used in your strategic planning activities at the NPD functional level?	
22	Do you consider your firm to be innovative? In what way?	
23	How would you describe your organisation's approach to the management of its new product development process (systematic or informal)?	
24	Does your approach to developing new products support or hinder the innovativeness of your organisation?	
25	What issues impact on your firm's reputation when it comes to developing new products?	
26	In developing new products, what outcomes does your firm seek?	
27	What could your organisation do to improve its new product development process?	

Appendix 4: CIMA Model Behaviours and Examples of Leavers

Behaviours

B1. *Individuals and groups use the strategic goals and objectives of the product innovation process to focus and prioritise their improvement and learning activities*
This is the combination of behaviours of both operatives and managers which results in peoples' attitudes towards selecting learning goals according to the priorities of the product innovation process. Management plays a crucial role in deploying corporate strategy and translating it into concrete improvement needs to which human resources can be committed.

B2. *Individuals and groups use innovation processes / projects as opportunities to develop knowledge*
People consider experimentation and learning as a part of the objective of each product innovation project. Failures are not condemned but regarded as experiences that can provide useful knowledge for further innovation activities. In planning and managing innovation projects, management pay close attention at balancing short-term objectives with the need for developing and diffusing knowledge for the overall organisation.

B3. *Individuals use part of the available time/resources to experiment with new solutions*
People have spare resources, in terms of time and/or budget, that can be devoted to activities that are explicitly aimed at developing knowledge or testing new solutions. Managers generally leave people a high degree of freedom in deciding how to use these spare resources to pursue innovation to which they feel personally committed.

B4. *Individuals integrate knowledge among all the different phases of product innovation*
People transfer and retrieve information from one phase to another of the innovation process, perceiving all the different phases of the CPI process to be closely related to each other. Organisational, space and time barriers that can emerge in this transfer are overcome by managerial and cultural awareness of knowledge transfer and integration.

B5. *Individuals transfer knowledge among different product innovation processes / projects*
People make explicit and communicate experience between different innovation processes and projects. They are aware of the value of sharing knowledge acquired in different PI processes / projects, and recognise the importance attached to this by the organisation. Similarly, when coping with a new problem people consciously look for previous experience that might be relevant.

B6. *Individuals abstract knowledge from experience and generalise it for application on new processes/projects*
People analyse their experiences to try to identify knowledge and information that are really important and may be applied in other situations.

B7. *Individuals embed knowledge into vehicles*
People systematically embed knowledge into vehicles such as people, reports, databases, product and process standards that can be more widely disseminated and retained over time.

B8. *People try to assimilate and internalise knowledge from external sources*
People act on their awareness that external actors (competitors, universities, research centres…), though not directly involved in the PI process, can be valuable sources of knowledge that can be usefully combined with the internal knowledge.

Levers can be described as activities undertaken by the organisation to encourage behaviours and make them more systematic and widespread.

Examples of Levers
1. Product Family Strategies
2. Innovation Process Definition
3. Organisation Integration Mechanisms
4. Human Resource Management Policies
5. Project Planning and Control
6. Performance Measurement
7. Design Tools and Methods
8. Computer-Based Technologies

Appendix 5: Sample Transcript Interview

Client: **C E O'Mara**

Project: **Interview with** [name deleted]
Assistant Workshop Co-ordinator,
[name deleted] **Ltd – 2 March 2007**

Recording Duration: 26 minutes (approximately)

Audio Quality: Good quality.

Other Comments:
Unclear words or phrases are depicted with a highlighted asterisk and timestamp, eg *22.43(unclear).

Items in [square brackets] are a guess on the part of the typist and may not be correct.

EO : C. Eddie O'Mara
XX : [name deleted]

FULL TRANSCRIPT

Question 1/2

EO Hello [name deleted]. Your role at [name deleted], how would you describe it?

XX We're just actually going through a slight change in structure. I was Assistant Co-ordinator… which, we have two sections here, so to one of the sections. And now I'm going in as a Co-ordinator and Product Development, say, Team Leader, as such, for those two things. So that's where it's moving. But not really officially yet.

Question 3

EO What would you say the principal products of [name deleted] are?

XX Principal products? Well, we classify as "internal" and "external". So internal is what we make for our head company at North Ryde, which is steering and special purpose machines for that, to support anything that they have. And then, our other line is external, which lies in high precision biomedical, photonics and special purpose press tools and stuff like that, so yeah.

Question 4

EO What do you think [name deleted]'s priorities in terms of a competitive strategy are?

XX The only way you can get any feedback is by listening to the managing directors and the way they come across, and every meeting they have, they'll put a spiel out, and one of the times, the general manager said that the only way to get ahead is to try and have more share of the market. So from what I've seen [name deleted] do, is try and grab more share of the market, and try and dominate, as such, their product. And that's really the only way you're going to get ahead, but at a competitive rate as well.

Question 5

EO So who determines the strategic priorities?

XX Well, that's determined from the Board and then the people up above. It's a bit of a conflict, because where we are now, we develop… External sales or external work

isn't a high priority for our head office because of the system we have here. Our head office is at North Ryde. Their priority is all their steering products and associated products with that, and we still need to support that. So as far as external stuff, it's left up to our company here at Villawood to fight and develop that, and have that as a shining light, as part of the business.

Question 6

EO When it comes to this business unit, here at Villawood, and its new product development strategy, what are the priorities when it comes to developing the new products?

XX Well, we're just going through a phase now where we've got three products, I think, that we're trying to get out. We'll talk to customers, to be a supplier for. And the way things are changed now is when we become a product supplier, a lot of it's in high volumes. Whereas, we've been traditionally a low volume, high quality workshop. But there's a niche market – or a need market – out there now, for high volume, high quality parts. Which we've never really been set up for. So for us, we've got to sit back, we've got to try and get as much information as possible from the services available out there to try and step into this market. And that's what we've been doing now, we've been getting R&D done, or sample parts done, all around the world from suppliers machinery, people that can add to our product, and get information and add technical assistance to our product, to then start us building up. And once we've got that, we can bring that all back in-house, and then take the next step - going out and finding more customers that suit that range of work.

Question 7

EO So how do you determine what the new strategy is going to be, in terms of the new product development?

XX A lot of the time, the product's either, come to us from a customer enquiry, or it comes to us from going out and putting our feelers out so the sales department come and bring the product back. Now, from there, normally, for us, it's something that most people can't do. So we spend a lot of time thinking about how we can do it, and how it can be cost-effective. So it's just a lot of talking, initial meetings, and then seeing whether it's viable. But for us, a lot of things, there's probably only two other companies in New South Wales that might want to touch it. So that's where we're at, what happens with our product development.

Question 8/9

EO You talked about new product development, and whether or not it's viable. How do you go about evaluating your new product development performance?

XX Evaluating?

EO Well, how do you measure NPD performance?

XX It's hard to say, because we're not at that level now where we've successfully pushed through a heap of new product development. For one-offs… let's go back on a smaller scale. If we have a couple of things that come in, and they say, "Oh, we want this, and it's very small and one-offs," customer feedback is the main thing. Because when you're talking small batch quantities, it becomes a very personal thing. If you've got two-off, the customer is probably sitting on your doorstep nearly every day. If it's good value. I've got one customer, and they're in the development stage, and they've said to me, "We've been all around Sydney, and no-one else has given us the service or has committed to doing what you've done." So we work very close

with them. That was the customer just then on the phone. He's going to be racing out this morning to get a job done, and I said, "Oh, not a problem. When you get over here—" So it's being able to provide on the smaller side, a personal service to these people, right, and a service they can rely on with a) quality and b) getting it out on time.

Question 10

EO Does anybody actually monitor the NPD performance?

XX In this situation, when it's a small product, it becomes a project, and you have a project leader. So from that point on, we have a weekly meeting, every week, and that job is flagged in the weekly meeting as part of a job within the company. If there are any issues, or anything that's needed to support that job, it can be brought up at that meeting, and then from the other department, it can be addressed or supported. But other than that, it comes down to the project leader that has to know that, has the job. He needs to do this. He knows all the steps that come out. And he's got the support behind him, but in that sort of small quantity, there is no real assessment form, right, it's all relying on the project manager.

Question 11

EO You talked about a project-based approach to new product development, and how you have a meeting and decide what support is needed. What types of action programs has your organisation preferred to pursue in an effort to improve NPD performance?

XX We have our quality system. Our quality system asks us to rank, in three categories, what the project or the job is. And it's a Level A, B or C. And these are ranked between difficulty and dollar value. So I think an A category might be up to $10,000 which is really – it can be not a particularly high technical job. But it could be if it was one part that was worth $10,000 and it fitted into the palm of your hand, it's probably a very technical part. And then also needs to be flagged up. But as you go up, you've got A, B and C. The C, which is large dollar value, complicated, we have a pre-launch meeting, and we have been having meetings every week, just to address any problems that come up, aside from our normal meeting. So you don't take the focus away from that project. You have a special meeting for that. So everybody's talking, and really, we found that, it might cost us to stop tools down, have a chat for 15, 20 minutes, but it will save us money in the long run.

EO So in terms of the actual action programs, for instance, CAD/CAM systems, formal continuous improvement activities… You did mention one that talks about a project approach?

XX CAD/CAM, well, nearly everything we do is CAD/CAM. So we just take it as normal that it's going to be on there. It's nothing new to us, it's not like, "Oh, we have to put it on CAD/CAM." For us, that's just natural. So we don't even think about that as being a tool. We know it's there, and we know who's available, and whoever is project-managing needs to know, out of the 20 people that are downstairs that are going to support the project. Who are the best people to go on there? You can't have Tom on there, when he's a welder, and there's no welding. So it comes down to the project leader having a think, having a talk, who's available to support the project. We always think after what we call a launch meeting, and there's any queries about the job, it will go back to, from that launch meeting, it will have a recommendation to go back to the customer and say, "Hey, we've got these problems. Can you come in and we'll sit down and talk about it?" So the launch meeting is virtually the start, the bit that kicks everything off, and lays the foundation for the project. Another thing that becomes a huge factor, and which we've found, is

external contractors. And even though you've promised your customer, you can be let down at the 11th hour by external contractors. And we're finding that's partly the problems we've been having lately. So really, the idea should be … I think, maybe, in the future, we could probably add that in as a special note – what external contractors they are, and are we confident that we're going to get the support from them to support the project? So that's one area, where we probably need to look at in-depth a bit more, because we have been let down in the past.

Question 12

EO That leads into the next question. Based on past performance, what actions will you pursue in the future? Closer collaboration with your suppliers is one action program that you could implement? That fits in nicely.

XX Yes, that would be what we'd be doing.

Question 13

EO Is there any other reason that might cause your firm to choose to pursue different improvement programs in future?

XX Oh, yeah. You've got to sit back and look at what the problems were… And we try and have a closure meeting. We should have a closure meeting, a meeting that comes back and talks about the problems. Because you can only learn by your mistakes, so we should come back and look at the problems. So, by doing that, you can flag up, then this can be added to the start, and then from that point on, we can ask these certain questions or look at a few things. Another area that has let us down is the Christmas break. Everybody wants to have four weeks' holiday. But because we do so much work for Europe and the States, they only have a couple of days. So it becomes very hard for us, and certain things, if you commit to a delivery, and then your supplier says, "Well, I'm having four weeks off," that's another real problem that you can have. So, just things like that, it's all done before the project is started that needs the greatest attention.

Question 14

EO You talked about those closure meetings to evaluate a project. When it comes to, say, an action program, let's say you've… for compatibility reasons, you've had to upgrade software on your CAD system. Let's say that was one of your action programs in relation to a new product that you're developing. Do you go about evaluating whether that was effective, or is that just included in the overall project evaluation?

XX It's included in the overall product evaluation, because I mean, the decision would be… It wouldn't be made just for a one-off or a spur-of-the-moment. You wouldn't implement that decision if it wasn't going to benefit down the track. Being a smaller company rather than a big, it's not going to affect… a kick-on effect on anything else. Because it's contained in a small… people can see the benefits of actually getting new software, new translators, I mean, you talk about software. Software comes in different formats. So you might say, "Well, I'm going to invest $2,000 in this translator," right, and over a period of time, yes it will become obsolete, but for the next 12 months, it will pay its way, because it will be able to translate X amount of different files and open the door to talk to these three customers.

EO Let's think of another action program. Let's go for one something like employee development and training. I know it's a big thing here. I know Lee is strongly into

apprentices and developing your own people and their skills. Are those kind of action programs evaluated?

XX Well, I don't believe they're evaluated. And that's a sort of… it's a hard thing to evaluate. Because there's no real right or wrong answer for that evaluation. You send an employee on a development program, they're only going to get out of it what they want to get out of it. It's out of your hands. You can put them on the path, and they can come back and say, "I've got this, this and this," and that's fine, all right, but to what level, and what effectiveness… I mean, if they've met the criteria of that course, that's fine, but how effective has it been? See, it's hard to say.

Question 15

EO What importance does your organisation place on team-based improvement efforts?

XX Well, we don't… at the moment… we used to have a strong team base set up. And with us looking at different avenues, and becoming slightly more focused on external rather than internal, people have swapped over from teams, so it's becoming project-driven rather than team-driven, and it's becoming, "That guy there is a part of that project till Wednesday", and then he's available to go on another project. So really, if you're going to say teams are evolving and changing the whole time, every day, every week…

Question 16

EO So what influences the make up of the team then?

XX Well, what influences it? Personalities is a huge part. You know, there's two people you couldn't put on a team, because you know it would stalemate, and you might have a personality clash. So you try and keep them project-based, separate, and a few other things. And it's knowing what skills are available to bring to the team at that point of time.

Question 17

EO What do you think drives these different action programs, in terms of what we're going to do? You know, where does the decision come from?

XX Well, that normally lies on the person directly responsible for it. I mean, most people… We probably have four people that head up their own projects. As the project comes in, they are given the project, and then, from that point, it relies on them and their knowledge and their base skill to then pass it down to make sure that works. So I'll get given a project or a development to do, and I'll say, "Okay. From the people that are available, *him, him* and *him* would be suitable. We don't need any more. And from there we're going to use *this*." And then, at that point, they will put their input in to start moving this project along. So it's more individual based, and the person who's in control of that project is where all the information stems from, it gets passed down.

Question 18

EO What do you think are the most useful performance measures used by the organisation to monitor and improve NPD performance?

XX Once again, we don't really have a hard 'yes or no' or 'one to five' performance appraisal on product development, as such. There is no set questions we ask, really, on how product development … how effective it was, or how it moved through the shop. It's quite, what we'd say, ad-lib, all right. In saying that, it's his [the project manager's] opinion on how it would work and how it should change, and at the end of

the day, there could be two opinions that are probably both right, but could be also totally opposite.

Question 19

EO So what do you think about the reliability of those kinds of NPD measures?

XX Oh, I think it could do with development, and we've never really got into it… As I said, when you're talking small quantities, close relationships to customers, personal service, it all comes down to the person who's doing the job. And the job's only as good as the guy that's got his hands on it, or the guy that's running the project. So we've never really had to have an extensive look-back and say, "Okay, how can we change it?" Because in those sort of things, they're changing all the time. But when you get to high volume, high production, then yes, you probably need to bring in some sort of set questions to analyse how you've been.

Question 20/21

EO So does that evaluation of NPD, whether it's a sort of end of project review or whatever, does that then feed back into strategic planning at all?

XX Yes, it does. Because the review will have everybody that's needed to be there, plus everybody else that's in the company of that level that can use the information that's supplied at the meeting. So you might have three other project leaders that weren't on that project, but they can come to the meeting to listen to see what had happened at that point in time.

EO We talked at the beginning about the business unit's competitive strategy, and it's trying to expand its market share is one of the things. From a new product development perspective, what strategies in NPD is the business unit using that might support the overall strategy?

XX I know that our quality… Everything's based on our quality system, and that's our underlying guidance, as such. I know we're going through now at the moment, and trying to do some changes to help us get in towards this sort of… this style of work. But I don't know if what we've got at the moment is actually helping us.

Question 22

EO Do you consider the firm to be innovative?

XX I think there's innovative people at the firm…

EO So, if you're saying, "Yes, the firm's innovative," in what way?

XX It's hard to say. My opinion is we're at a fork in the road, and it's been brought about with engineering in general throughout Australia. And we're at a point where we need to become… We need to try and take some more share in different markets, and that's what we're trying to do, different styles of work. Yes, by doing that, we're innovative, but maybe we're not up to the level that we should be, to probably take more. So there's still a long way to go.

EO I guess in terms of innovation, it's really complex. Are you product-innovative? Are you process innovative? Or what's the mix?

XX Well, I mean, we're talking external work here. And that's where this all ties in. We don't develop our own product, as such, for external customers. Customers come to us to manufacture their product. So then, really, development-wise, well, there's only

development and process to manufacture that product. So, as far as development of product and then development of process, it's not what we really do, because we don't have people here. At our other office, yes, they're developing their own product, and then they'll come here and they'll get it manufactured, but that's not really what we have to look after. But by going out and getting high-volume, high-precision stuff, which will fit into a product, it needs to be controlled and it needs to be looked after, otherwise you'll lose a lot of money right from the start.

Question 23

EO How would you describe the organisation's approach to the management of its new product development process? Think in terms of a scale of 'very systematic' to 'informal'.

XX I'd say probably six months ago, it would have been very informal, and we're building up to a stage now where it's somewhere in the middle. I mean, I still think there's lots of other little things to do. And you'll only know that by going through the motions every time, and then coming back and saying, "Okay, well, how about we add this in here, or we do this, or we create that as a standard document, or a few things that will help)"… Now, I can see us moving forward in that direction. I just don't think we're at that level yet.

Question 24

EO So, does the approach to new product development support or hinder innovativeness in the organisation?

XX Well, I don't think it hinders. I don't think it hinders. For example, if a product comes to me, then I'll just go sit back and do what I have to do. And I'll come back and say, "There it is there, sell that to the customer." So everything is reliant on me, it's a one-stop shop. So really, the only hindrance is, is if someone comes up and bothers me, I suppose.

Question 25

EO What issues are relevant to your firm's reputation when it comes to developing new products?

XX Well, quality and on-time delivery. Quality mainly. But on-time delivery needs to be there. Everybody wants it yesterday. And really, when you're chasing… You can't go back. You haven't calculated for that re-work. You don't have the time. You don't have the machine available. You know, it's just… Your quality's got to be in there too.

Question 26

EO So, when producing these new products, what outcomes does the firm seek?

XX Well, the outcome set before they even accept the challenge of doing the project, that it's going to be viable, economically, and physically able to manufacture. You don't want to get in there and find out that the job wasn't really… we had a half-hearted attempt at it. You know, that's the position you don't want to be in. So you've just got to cover all bases that you've put your name to it. And at the end of the day,

that's what you're doing, you're putting your name to that job, and you've got to stand by your name.

Question 27

EO What do you think your organisation should do to improve its NPD performance or its NPD process?

XX Well, I haven't got any real answers for it. Back to what I was saying, I don't believe we're striving for that stage. And for what we've done up until that has been satisfactory, okay. It's worked. But only on a personal scale. But when you start talking…oh, being a little bit bigger, being multiple parts, you know, and having more work flow through, I think it needs to be developed. I think there's a development plan that needs to be in place. And probably any information we can get from outside would help.

EO Thanks [name deleted].

END OF TRANSCRIPT

Appendix 6: New Product Development Performance Dimensions

The NPD performance dimensions that business units quantitatively measure or qualitatively assess as taken from question 2.5 of the New Product Development Practices and Performance questionnaire

Performance Dimension
Average NPD project lead-time °
Percentage of projects over-running planned project lead time
Average time-to-market °
Percentage of projects over-running planned time-to-market
Percentage of projects over-running budget
Direct NPD cost °
Indirect NPD cost °
Number of engineering design changes

Value added time
Annual value added
Capacity utilisation °
Number of new product ideas evaluated
Percentage of sales from new products
Market share of new products
Percentage of NPD projects completed successfully
Number of projects the business unit is engaged in at any one time

Product functionality °
Conformance quality °
Production cost of new products
Manufacturability/assemblability of new products °
Level of modularisation of new products °
Extent to which new product designs are based on (a) common platform(s) °
Innovativeness of the NPD function °
Product customisation capability °
Reputation of the NPD function
Environmentally sound products

Appendix 7: New Product Development Action Programs

Formal continuous improvement programme
Self-managing/empowered NPD teams
Flexible, multi-disciplinary NPD staff
Use of cross-functional teams °
Administrative routines
Employee commitment/attitude towards change
Employee skills
New computer-aided design tools (e.g. CAD °, CAM °, CAE °)
New non-computerised tools and techniques (e.g. QFD °, FMEA °)
Customer participation in NPD
Supplier participation in NPD
Participation of marketing/sales in NPD
Participation of production in NPD
Involvement of universities and research institutes in NPD
Concurrent Engineering °
Benchmarking other companies' NPD practices and performance
Formal management approaches or systems (e.g. TQM °, ISO 9000, project management)

Cross-functional teams – Teams of employees representing different functional disciplines and/or different process segments who tackle a specific problem or perform a specific task, frequently or on an ad hoc basis.

CAD - Computer Aided Design
CAM - Computer Aided Manufacturing
CAE - Computer Aided Engineering

FMEA - Failure Mode and Effect Analysis
QFD - Quality Function Deployment

Concurrent Engineering – A cross-functional, team-based approach in which the product and the manufacturing / assembly process are designed and configured within the same time frame, rather than sequentially. Ease and cost of manufacturing and assembly, as well as customer needs, quality issues and product-life-cycle costs are taken into account early in the development cycle. Fully configured concurrent engineering teams include representation from marketing, design engineering, manufacturing