

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

An Empirical Investigation into the Use of Product Development in the Educational Furniture Industry

A thesis presented in fulfilment of the requirements for the
Master of Technology in Product Development
at Massey University,
Palmerston North, New Zealand.

Jeffrey Martin Morgan

2001

Abstract

An empirical investigation into the use of product development in the educational furniture industry is summarised in this thesis. New Zealand furniture manufacturers are facing increased competition from imported furniture and are also exporting more and more furniture. Developing new products is therefore important to the New Zealand furniture industry's growth.

This research was based on a small furniture-manufacturing firm from Hastings, New Zealand called Furnware Industries Limited (Furnware). A product development process was developed to their specific needs by comparing their current product development activities with identified best practices in product development. Those parts of the current activities that worked well were amalgamated with the structured Stage-GateTM process of Cooper (1998).

This process was tested by using it to develop a Mobile Technology Education Workstation range for Furnware. The aim of the project was to develop a new product for Furnware to sell and to simultaneously test the developed process. Once the project was completed, an evaluation of the product development process used was undertaken. Several areas for improvement were identified and a revised process outlined.

The use of Computer-Aided Design (CAD) software was identified as another area of improvement that would assist both product development activities and existing manufacturing processes at Furnware. Consequently, a CAD package best suited to Furnware is selected using a structured process.

The three main outcomes of the research were:

1. A product development process suited to Furnware.
2. A Mobile Technology Education Workstation range of products ready for launch, pending minor adjustments and testing.
3. A CAD software package suggested for use at Furnware.

Acknowledgements

I would like to thank all those who helped make this thesis possible. In particular I would like to thank:

My supervisor, Aruna Shekar for her guidance and support throughout the year.

The company sponsors, Furnware Industries Limited for allowing this research to be conducted on their company, with their support and assistance. In particular Hamish Whyte and Graeme Dickey for their input and guidance. Other Furnware staff that helped significantly who I wish to thank include: Jason Wilton, Huib Pronk, Sue Hay, Kevin Higginson and Dave Henare.

Technology New Zealand for their funding support in the form of a Graduate in Industry Fellowship (GRIF).

All other people who helped keep me sane throughout. In particular Carl Sheridan and Tom Robertson.

Table of Contents

1	INTRODUCTION.....	1
1.1	COMPANY BACKGROUND.....	1
1.1.1	<i>History.....</i>	<i>1</i>
1.1.2	<i>Current Product Range.....</i>	<i>1</i>
1.1.3	<i>Business Strategy.....</i>	<i>2</i>
1.2	OVERALL RESEARCH METHOD	3
1.3	EXISTING COMPANY PROCESSES.....	4
1.4	PRODUCT DEVELOPMENT THEORY.....	5
1.5	BEST PRACTICES IN PRODUCT DEVELOPMENT	6
1.6	REVISED PRODUCT DEVELOPMENT PROCESS	6
1.7	MOBILE TECHNOLOGY EDUCATION WORKSTATION PROJECT.....	7
1.8	PROJECT EVALUATION.....	8
1.9	CAD SELECTION.....	8
1.10	SUMMARY.....	9
2	LITERATURE REVIEW.....	10
2.1	INTRODUCTION.....	10
2.2	EXISTING PRODUCT DEVELOPMENT PROCESSES	10
2.2.1	<i>Cooper's Stage-GateTM Process</i>	<i>10</i>
2.2.2	<i>Earle's Product Development Process</i>	<i>13</i>
2.2.3	<i>Ulrich and Eppinger</i>	<i>15</i>
2.3	BEST PRACTICES OF NEW PRODUCT DEVELOPMENT PROCESSES	18
2.4	NEW ZEALAND COMPANY ENVIRONMENT.....	20
2.4.1	<i>Business Reforms: 1984- present.....</i>	<i>20</i>
2.4.2	<i>Small and Medium-sized Enterprises.....</i>	<i>22</i>
2.4.3	<i>Product Development.....</i>	<i>22</i>
2.4.4	<i>Comparisons Among Industries.....</i>	<i>24</i>
2.5	FACTORS AFFECTING PRODUCT DEVELOPMENT AT FURNWARE	25
2.5.1	<i>Product Development in the Furniture Industry.....</i>	<i>26</i>
2.5.2	<i>Product Development and the Educational Furniture Market.....</i>	<i>27</i>
2.6	REVIEW OF EDUCATIONAL FURNITURE DEVELOPMENT AREAS	28
2.6.1	<i>Technology Curriculum in New Zealand Schools.....</i>	<i>28</i>

2.6.2	<i>Computer Usage in Schools</i>	32
3	PRODUCT DEVELOPMENT PROCESS SELECTION	35
3.1	INTRODUCTION.....	35
3.2	METHODOLOGY	35
3.3	RESULTS	37
3.3.1	<i>Part 1: Current Product Development Methodologies at Furnware</i>	37
3.3.2	<i>Outcomes: Process Description</i>	42
3.3.3	<i>Part 2: Analysis of Furnware's Product Development Process</i>	44
3.3.4	<i>Outcomes</i>	46
3.3.5	<i>Part 3: Analysis of Current Structured Processes</i>	46
3.3.6	<i>Outcomes</i>	48
3.3.7	<i>Part 4: Revised Process</i>	49
3.3.8	<i>Outcomes</i>	56
3.4	SUMMARY	57
4	STAGE 1: PRELIMINARY INVESTIGATION	58
4.1	INTRODUCTION.....	58
4.2	METHODOLOGY	58
4.2.1	<i>Technology Curriculum</i>	58
4.2.2	<i>Computer Usage in Schools</i>	58
4.2.3	<i>Audio Visual Equipment</i>	59
4.2.4	<i>Decision</i>	59
4.3	RESULTS	59
4.3.1	<i>Technology Curriculum Mobile Workstation</i>	59
4.3.2	<i>Computer Related Mobile Workstation</i>	59
4.3.3	<i>School Visits</i>	60
4.3.4	<i>Audio Visual Equipment Mobile Workstation</i>	64
4.4	OUTCOMES.....	64
4.4.1	<i>Project Brief</i>	65
4.5	SUMMARY	65
5	STAGE 2: CONCEPT GENERATION	66
5.1	INTRODUCTION.....	66
5.2	DETAILED INVESTIGATION.....	66

5.2.1	<i>Market Analysis</i>	66
5.2.2	<i>Consumer Analysis</i>	74
5.2.3	<i>Product Analysis</i>	77
5.3	CONCEPT GENERATION.....	84
5.3.1	<i>Aim</i>	84
5.3.2	<i>Methodology</i>	84
5.3.3	<i>Results</i>	85
5.3.4	<i>Outcomes</i>	95
5.4	SUMMARY.....	95
6	STAGE 3: DETAILED DESIGN	96
6.1	INTRODUCTION.....	96
6.2	ERGONOMIC ANALYSIS.....	96
6.2.1	<i>Aim</i>	96
6.2.2	<i>Methodology</i>	96
6.2.3	<i>Results</i>	97
6.2.4	<i>Outcomes: Design Solutions</i>	100
6.3	PROTOTYPING: STAGE 1.....	102
6.3.1	<i>Aim</i>	102
6.3.2	<i>Methodology</i>	102
6.3.3	<i>Results</i>	102
6.3.4	<i>Outcomes</i>	109
6.4	CONCEPT DEVELOPMENT.....	110
6.4.1	<i>Introduction</i>	110
6.4.2	<i>Aim</i>	112
6.4.3	<i>Methodology</i>	112
6.4.4	<i>Results</i>	112
6.4.5	<i>Outcomes</i>	118
6.5	SUMMARY.....	118
7	STAGE 4: TESTING AND COMMERCIALISATION	120
7.1	INTRODUCTION.....	120
7.2	FINAL PROTOTYPE DEVELOPMENT.....	120
7.2.1	<i>Aim</i>	120
7.2.2	<i>Methodology</i>	120

7.2.3	<i>Results</i>	121
7.2.4	<i>Outcomes</i>	124
7.3	CONCEPT FUNCTIONALITY TEST	125
7.3.1	<i>Aim</i>	125
7.3.2	<i>Methodology</i>	125
7.3.3	<i>Results</i>	126
7.3.4	<i>Outcomes</i>	128
7.4	CONSUMER APPEAL TEST	128
7.4.1	<i>Aim</i>	128
7.4.2	<i>Methodology</i>	128
7.4.3	<i>Results</i>	128
7.4.4	<i>Outcomes</i>	129
7.5	STRUCTURAL INTEGRITY	129
7.5.1	<i>Aim</i>	129
7.5.2	<i>Methodology</i>	130
7.5.3	<i>Results</i>	130
7.5.4	<i>Outcomes</i>	131
7.6	COMMERCIALISATION	134
7.6.1	<i>Introduction</i>	134
7.6.2	<i>Product Strategy</i>	134
7.6.3	<i>Business Strategy Fit</i>	135
7.6.4	<i>Marketing and Launch Plans</i>	136
7.6.5	<i>Production Plan</i>	139
7.7	SUMMARY	141
8	PRODUCT DEVELOPMENT PROCESS EVALUATION	143
8.1	INTRODUCTION	143
8.2	METHODOLOGY	143
8.3	RESULTS	144
8.3.1	<i>Part 1: Stage by Stage Evaluation</i>	144
8.3.2	<i>Part 2: Overall Process Evaluation</i>	149
8.4	OUTCOMES: REVISED PROCESS	151
8.4.1	<i>Overview</i>	151
8.4.2	<i>Company Knowledge and Leadership</i>	152

8.4.3	<i>Ideation and Idea Selection</i>	152
8.4.4	<i>Preliminary Investigation</i>	152
8.4.5	<i>Concept Development</i>	154
8.4.6	<i>Commercialisation</i>	154
8.5	SUMMARY	155
9	CAD SELECTION	156
9.1	INTRODUCTION.....	156
9.2	PART 1: FURNWARE’S NEEDS AND CURRENT CAPABILITIES	157
9.2.1	<i>Aim</i>	157
9.2.2	<i>Methodology</i>	157
9.2.3	<i>Results</i>	157
9.2.4	<i>Outcomes: Furnware’s CAD Requirements</i>	163
9.3	PART 2: CAD TECHNOLOGY RESEARCH	163
9.3.1	<i>Aim</i>	163
9.3.2	<i>Methodology</i>	163
9.3.3	<i>Results</i>	164
9.3.4	<i>Outcomes</i>	164
9.4	PART 3: CAD SELECTION.....	164
9.4.1	<i>Aim</i>	164
9.4.2	<i>Method</i>	164
9.4.3	<i>Results</i>	165
9.4.4	<i>Outcomes: CAD Software Selection</i>	169
9.5	SUMMARY	170
10	CONCLUSIONS AND RECOMMENDATIONS	171
10.1	INTRODUCTION.....	171
10.2	PRODUCT DEVELOPMENT PROCESS.....	171
10.2.1	<i>Conclusions</i>	171
10.2.2	<i>Recommendations</i>	172
10.3	MOBILE TECHNOLOGY EDUCATION WORKSTATION PROJECT.....	172
10.3.1	<i>Conclusions</i>	172
10.3.2	<i>Recommendations</i>	172
10.4	CAD SELECTION.....	173
10.4.1	<i>Conclusions</i>	173

10.4.2 Recommendations 173

10.5 SUMMARY 174

List of Figures

Figure 1-1 Examples of Existing Furnware Products	2
Figure 1-2 Overall Research Method	4
Figure 2-3 Overview of Coopers Typical Stage-Gate™ Process	12
Figure 2-4 Product Development Process of Earle (1999)	14
Figure 2-5 Ulrich and Eppinger's Generic Product Development Process.....	17
Figure 2-6 Kerr's Typical PD Process in New Zealand Small Companies	24
Figure 2-7 Technology Curriculum Framework	30
Figure 2-8 Example of Technology Education Project.....	31
Figure 2-9 Architectural Plans for Technology Education	32
Figure 3-10 Product Development Process Selection Method	36
Figure 3-11 Sample of Mayfair Office Furniture Range	41
Figure 3-12 Current Product Development Process at Furnware	43
Figure 3-13 Revised Product Development Process.....	50
Figure 4-14 Images of Computer Use and Technology Equipment in NZ Schools	63
Figure 5-15 Types of Intermediate and Primary Schools in New Zealand: 1997.....	68
Figure 5-16 Ages of Children in Primary Schools: 1997.....	69
Figure 5-17 School Rolls of New Zealand Schools: 1998.....	69
Figure 5-18 Wholesale Learning Technology Trolley.....	70
Figure 5-19 Mobile Suitcases: Hillcrest School, Pahiatua.....	71
Figure 5-20 Auckland College of Education Mobile Units	72
Figure 5-21 Technology Room Examples	73
Figure 5-22 Heron Technology Units	74
Figure 5-23 Resource Priorities for the Different Technology Areas.....	80
Figure 5-24 School Environment: Examples of Ramps.....	81
Figure 5-25 Concept Generation Methodology	84
Figure 5-26 Sub-Problem Identification	86
Figure 5-27 Concept Generation Sketches.....	87
Figure 5-28 Creative Sketch Examples.....	89
Figure 5-29 Tool Storage Classification Tree	90
Figure 5-30 Examples of Concepts Generated by Systematic Exploration	92
Figure 5-31 Concept Images	93
Figure 6-32 Range of Children Sizes and Appropriate Workbench Height	99

Figure 6-33 Range of Tasks Completed On Workstation.....	100
Figure 6-34 Examples of Work Surface Lifting Mechanisms	101
Figure 6-35 Lifting Mechanisms.....	104
Figure 6-36 Vertical Drawer Prototypes	106
Figure 6-37 Surface Prototype Development.....	108
Figure 6-38 Workstation Chassis Design.....	113
Figure 6-39 Saw Drawer and Glue Gun Drawer.....	114
Figure 6-40 Small Compartment Drawer and Food Preparation Drawer	116
Figure 6-41 Stainless Steel Worktop	118
Figure 7-42 Functionality Testing of Materials Technology Workstation	126
Figure 7-43 Functionality Testing of Food Technology Workstation	127
Figure 7-44 Physical Testing of Final Prototype	131
Figure 7-45 Flowchart of Typical Marketing Activities Carried Out at Furnware.....	137
Figure 7-46 Images of Final Prototypes in Furnware Brochure	139
Figure 7-47 Solid wood and Panel Processing at Furnware	140
Figure 7-48 Steel Processing at Furnware	141
Figure 8-49 Revised Product Development Process.....	153
Figure 9-50 Overall Computer-Aided Design Software Selection Methodology.....	156
Figure 9-51 Current One-Off Design Process of Furnware Industries LTD	159
Figure 9-52 Furnware Industries Current New Product Development Process.....	161
Figure 9-53 Rendered Image of Mobile Workstation	169

List of Tables

Table 2-1 Economically Significant Enterprises, 1998.....	22
Table 3-2 Product Development Process Evaluations	48
Table 5-3 Initial Target Specifications.....	83
Table 5-4 Food Technology Equipment	88
Table 5-5 Initial Combination Table.....	91
Table 5-6 Final Combination Table	91
Table 5-7 Concept Screening Table.....	95
Table 6-8 Lifting Mechanism Prototype Schedule	103
Table 6-9 Vertical Drawer Prototype Schedule	105
Table 6-10 Portable Surface Prototype Schedule.....	107
Table 7-11 Materials Technology Workstation Prototype Schedule	121
Table 7-12 Food Technology Prototype Schedule.....	123
Table 7-13 Physical Testing Results	130
Table 7-14 Mobile Technology Education Workstation Models.....	133
Table 7-15 Product Sales and Market Share Objectives.....	134

1 Introduction

Product Development is the process of turning ideas into new products. This thesis outlines the use of product development in the furniture industry. The furniture industry in New Zealand is facing increased competition from overseas furniture manufacturers due to ever decreasing import tariffs. "Imports for the December 2000 year totalled US\$216 million which was an increase of 9.3% over the previous year", (Dunnett, 2001). The low value of the New Zealand dollar has provided better opportunities to compensate for this new market pressure by increasing furniture exports. "Due to increasing import competition and a greater export focus, New Zealand companies are concentrating on qualities such as unique design, quality, delivery and service...", (Dunnett, 2001). The development of new furniture products is therefore important to the New Zealand furniture industry's growth. This thesis outlines the use of a structured product development process to develop a new furniture product. The process is evaluated at the conclusion of the project and refined to better suite the sponsor company's situation. It is recommended that this process be used for future projects to help improve product development at Furnware. As with any newly adopted process it should also be improved over time.

1.1 Company Background

1.1.1 History

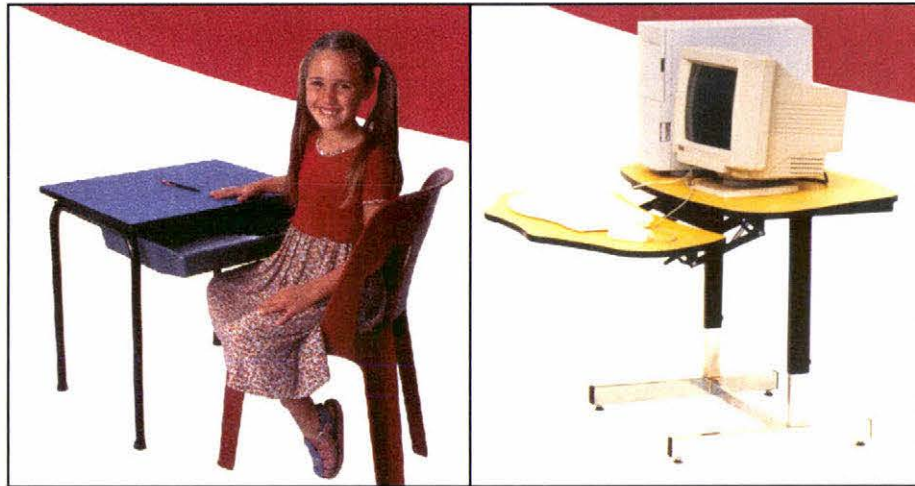
Furnware is a furniture manufacturing company located in Hastings, New Zealand. Furnware began operations in 1934 and has been a manufacturer of products ranging from children toys to coffins. Since then the company has also been a manufacturer of caravans and a supplier of kitchens for government houses. The company has also had a number of owners from large corporate companies to the present, privately owned and operated setting.

1.1.2 Current Product Range

Furnware currently manufacture products for the education, healthcare/rest home and domestic solid timber markets. The recent purchases of two companies: Permakraft Furniture and Eagle Furniture has increased the product range to over 600 standard

products. Permakraft produce household solid wood furniture, while Eagle and Furnware focus on educational furniture. Several examples of the current furniture range are given below in Figure 1-1.

Figure 1-1 Examples of Existing Furnware Products



(Source: Furnware Industries Limited product catalogue 2001)

1.1.3 Business Strategy

1.1.3.1 Product

To produce high quality, well designed furniture at a reasonable cost. Product innovation and quality play a key role in protecting sales prices that are higher than the market norm. The ability to supply customers with ‘one-off¹’ designs, thus better meeting the customers’ needs is another key factor in Furnware’s product strategy.

Furnware’s current commitment to research is the result of a change in product development strategy, from being a reactor to market changes and customer demands, to being a market leader in supplying products that meet customer needs.

1.1.3.2 Marketing

Furnware’s market strategy involves building strong relationships with key customers, such as school principals and then developing long-term relationships. The location of sales representatives throughout New Zealand allows Furnware to contact customers on

¹ One-off designs are new product designs that have been specifically requested by a customer. Sometimes referred to as custom designs.

a regular basis. Furnware is currently establishing itself in the US market, by partnering with several other New Zealand companies and the New Zealand Trade Development Board (TRADE NZ). This is expected to provide a much larger customer base, as well as an increase in sales during the traditionally slow sales months of the New Zealand winter (June-September).

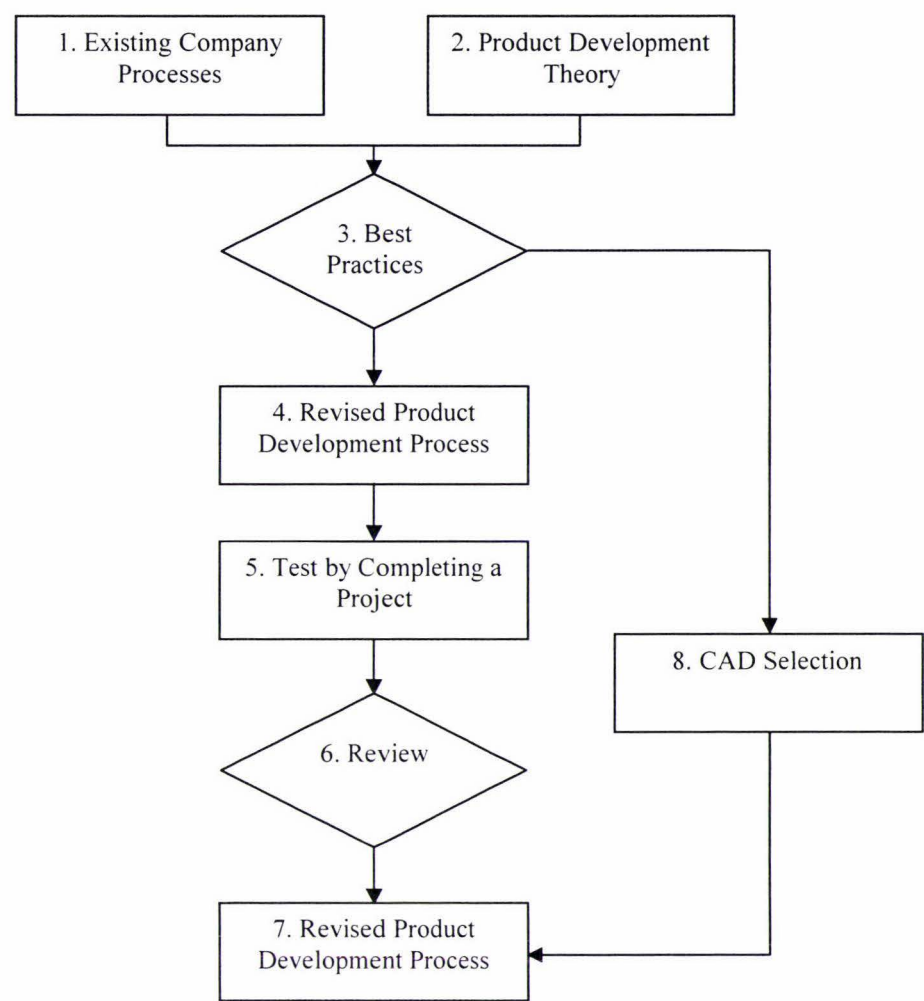
1.1.3.3 Production

To manufacture products as economically as possible, while maintaining current product quality. Production strategy involves the development of a system that can produce both standard and 'one-off' products by the date required by the customer, and be flexible and cost effective. Raw materials used consist of Medium Density Fibreboard (MDF), Melteca, solid wood (Rimu and Pine) and mild steel. The steel used is predominantly round or square tube of varying dimensions.

1.2 Overall Research Method

Provided below in Figure 1-2 is the flowchart for the overall research method. This research was based on Furnware's operations. A combination of research into existing company product development activities and product development theory was conducted. These two areas were used to develop a product development process for Furnware. Identified best practices were researched and used to provide guidelines for the revised product development process. This process was then used to develop a product idea. The purpose of this project was to develop a new product for Furnware and to simultaneously test the proposed product development process. After completing the project, the process is evaluated and revised to better suite Furnware's needs. The use of CAD technology was identified as a key factor in improving product development and production at Furnware, consequently research into which CAD package would most suite Furnware was also done. Provided below is a brief introduction to each of the research areas.

Figure 1-2 Overall Research Method



1.3 Existing Company Processes

Furnware is a small furniture manufacturing company located at Hastings, New Zealand. This company agreed to partner this research project. This section covers research into Furnware, in particular existing product development methodologies. A brief history and product background is also given. To research current product development activities at Furnware two case studies were used. These studies each reviewed a recent development project undertaken at Furnware. The studies resulted in the development of a current general process that is used at Furnware. The process is informal and most projects do not follow all the steps.

1.4 Product Development Theory

Research into current product development processes was conducted to help improve product development at Furnware. The processes will be used to provide a basis from which a product development process suited to Furnware's particular situation is developed. The details of this development are provided in Chapter 3: Process Selection.

Cooper (1998) presents a five-stage, stage-gate process that suites Furnware's industry situation. The five stages are:

- Stage 1 Preliminary Investigation.
- Stage 2 Detailed Investigation.
- Stage 3 Development.
- Stage 4 Testing and Validation.
- Stage 5 Full Production.

Gates divide the stages. The gates represent times in the process where top management makes decisions on the project. They also approve an action plan for the next stage.

Earle (1999) also outlines a structured process with stages divided by decision points. The process has four stages.

- Stage 1 Product Strategy Development.
- Stage 2 Product Design.
- Stage 3 Product Commercialisation.
- Stage 4 Product Launch and Evaluation.

Decision points where top management makes a Go or No-go decisions on the project separate these stages. This process is more suited to the development of food products than furniture products. The use of a structured process, with clear decision points is consistent with Coopers process though.

The third process outlined is that described by Ulrich & Eppinger (2000). They outline a generic process with six stages.

- Stage 0 Planning.
- Stage 1 Concept Development.
- Stage 2 System-level Design.
- Stage 3 Detailed Design.
- Stage 4 Testing and Refinement.

Stage 5 Production Ramp-up.

Ulrich & Eppinger illustrate the multi-disciplinary approach to product development by listing the typical tasks needed to be carried out by marketing, design and manufacturing at each of the stages. This process is best suited to a product that incorporates a high level of engineering due to the emphasis on testing and works well for high-volume production companies because it incorporates a production ramp-up stage. Ulrich & Eppinger include Stage 0 Planning in their process; this is an important part of product development within a company. While not included in Coopers process he does consider it critical to successful product development. Research into these processes assisted the development of a product development process at Furnware by providing structured approaches to product development. Chapter 3 outlines the development of a product development process suitable for use at Furnware that is based on Coopers Stage-GateTM process.

1.5 Best Practices in Product Development

Best practices in product development are those activities conducted by companies that improve product development within the company. Griffin (1997) summarises the results of a Product Development Management Association (PDMA) research project into best practices in product development. The main findings are provided in the literature review. The report also discusses current product development trends. Cooper (1998) also provides practices that are undertaken by companies that are successful at product development. He identifies three cornerstones of success.

- Having a new product strategy.
- Having the right resources.
- Having a new product process that works.

He identifies five success factors in developing a high quality process as well. These are summarised in the literature review. These best practices are used to determine in which areas Furnware should improve in their product development activities.

1.6 Revised Product Development Process

A product development process is developed for Furnware by combining current practices at Furnware with identified product development processes. To do this a comparison is made between, the best practices and Furnware's current practices. From

this analysis two areas were chosen for improvement. The first was the use of a structured product development process and the second was the use of CAD technology. Using CAD technology to increase design efficiency will help the product development process at Furnware as well as improve current manufacturing processes. Research into this area is provided in Chapter 9 of the thesis.

The research into the existing product development processes of Cooper, Earle and Ulrich & Eppinger is used to develop a structured product development process for Furnware. Cooper's process is selected as the basis for the new process. The new process also incorporates current activities identified as already working well at Furnware.

1.7 Mobile Technology Education Workstation Project

The development of a product for Furnware was done for two reasons.

1. To test the process developed for Furnware.
2. To develop a product Furnware could sell and profit from as a part of their existing range of furniture.

The development of a Mobile Technology Education Workstation range started with an investigation into three product areas:

- A mobile workstation for the technology curriculum.
- A mobile workstation for computer equipment.
- A mobile workstation for audio-visual equipment.

The preliminary investigation into these areas led to the decision to develop a workstation for the Technology Curriculum in primary schools. The project brief was:

To design a Mobile Technology Education Workstation that will assist in the practical component of technology education in primary schools in New Zealand. The workstation will attempt to cover all the areas of the Technology Curriculum. If this is not feasible, a family of workstations will be developed. The unit will provide both storage and working surface suitable for conducting typical practical technology education activities.

A detailed investigation into this specific product area was completed next. A target market was identified; competitor products analysed and consumer needs information was collected. Generation of concepts was done using a structured five-stage method.

The outcome, after screening was two concepts chosen for further development. To develop the concepts into final product designs a series of prototyping, testing and concept development was done. The concepts were developed to a stage where one idea was selected for final prototyping and testing.

There were three final tests done on the workstation. Concept functionality testing to ensure the design functioned well. Consumer appeal testing to ensure aspects such as aesthetics and price were acceptable. Structural integrity testing was the final test done. The workstations passed these tests with only a few design modifications suggested. Finally commercialisation plans are presented.

1.8 Project Evaluation

Once the Mobile Technology Education Workstation project was completed, the process used could be evaluated. The process is evaluated both by development stage and as a whole. Interviews with top management at Furnware provided the basis for much of the evaluation. A review of the literature summarised in Chapter 2 helped provide suggestions for future improvement, as did the suggestions from the top management evaluation. A revised process that integrates Stages 2 & 3 of the process used to develop the Mobile Technology Education Workstation into a single, cyclic process is the result of this evaluation. Incorporation of company knowledge and top management is also added into the process.

1.9 CAD Selection

During the comparison of current practices at Furnware and identified best practices in product development, the use of engineering tools was identified as an area that Furnware could benefit from in both product development activities and existing manufacturing processes. Consequently a CAD package is selected for use at Furnware. The selection process included:

- Collecting information on all of Furnware's current needs.
- Researching the CAD software packages available.
- Conducting an initial screen of packages by ensuring they had the features required by Furnware.

- Completing a second, more detailed financial analysis on the remaining packages to determine which package would provide the greatest return on investment (highest Net Present Value).

The software package that rated highest in the NPV analysis was not considered the best overall though, due to qualitative factors that could not be incorporated into the analysis.

1.10 Summary

This chapter introduces the sponsor company, Furnware Industries Limited and the main areas of research that this thesis covers. The structure of the overall thesis is provided and a clear explanation for why each of the areas was researched is summarised. Each section is then introduced and a brief description of the activities conducted and outcomes from them given. This chapter precedes Chapter 2: Literature Review, which provides a summary of the current, relevant literature on this topic.