Best Practice, Employee Performance and Manufacturing Performance.

Submitted in total fulfilment of the requirements of the degree of Doctor of Philosophy

Challis, David T.,
Centre For Manufacturing Management,
Melbourne Business School.
September 1996.
To Mardi, Anna, Stephen and Clare for their Love and Patience
DECLARATION

I declare that this thesis:

- is less than 100,000 words in length, exclusive of tables, diagrams, bibliographies and footnotes.

- consists only of my original work. All other material used is given appropriate acknowledgement within the body of the text.

David Challis
ACKNOWLEDGEMENTS

I would like to thank Professor Danny Samson for his guidance, encouragement and support throughout my doctoral program at the Melbourne Business School. His active and ongoing involvement, despite shouldering a prodigious workload, was instrumental in shaping the content of this work and facilitating its progress. His mentorship, enthusiasm and good humour were also invaluable in providing me with the confidence and desire to progress beyond my “comfort zone” and explore issues within areas that I had not worked previously.

I would also like to thank Professor Leon Mann for his work with RATWS, Work in Progress and other forums and processes at the Business School that contribute to the creation of a working environment that nurtures research and fosters a spirit of cooperation between researchers.

One of the largest obstacles to conducting empirical research involves the cooperation of senior manufacturing executives. This cooperation is essential in order to gain critical data and access to key personnel. The ability of the Melbourne Business School, and in particular, the Centre For Manufacturing Management, to forge strong linkages with industry and associated organisations over a lengthy period of time has created an infrastructure that substantially assisted in this regard. I would therefore like to acknowledge the efforts of all those within the school who have been responsible for fostering these close linkages between academic staff and industry.

I would also like to acknowledge the efforts of Steve Ford in critiquing the statistical analysis component of this work. His comments and assistance were greatly appreciated.

Finally, I would like to acknowledge my family for its tireless support and patience and my close friend John Stevens, for his enthusiasm, advice and interest during the last four years.

David Challis, August, 1996
This research is concerned with the relationships between various technological, organisational and human resource investments, commonly termed Best Practices, and employee performance and manufacturing performance. Best Practices considered include: Total Quality Management (TQM), Just In Time (JIT), Advanced Manufacturing Technology (AMT), Strategic Planning, Leadership, Teams, Benchmarking and Training.

The research uses two major pieces of field work. First, it analyses the practices and performance of 1024 Australian and New Zealand Manufacturing firms with a view to identifying "what works". This element of the research project tests a range of propositions concerned with the associations between Best Practices and measures of employee and manufacturing performance. Second, a detailed suite of case studies describing the Best Practice experiences of twelve Australian Manufacturers are analysed to assess "how it works". In particular, this area of research seeks to gain insights into how Best Practices relate to improvements in performance.

Key findings include:

- a moderate to strong association between employee performance and manufacturing performance,
- TQM, JIT and leadership are key differentiators of employee performance and manufacturing performance,
- AMT is positively associated with manufacturing performance but only in a strong TQM environment,
- the strength of the associations between TQM, JIT and manufacturing performance increases with strength of AMT environment,
- TQM explains approximately twice the variance in performance in weak manufacturing performance environments compared to strong manufacturing performance environments.
The implications of these findings for existing conceptual theories, current research methodologies, theory development and practitioners are discussed in considerable detail.

Although the research concludes that firms investing in Best Practices generally outperform those which do not, it also provides a number of salient notes of caution. In particular, it was found that firms need to introduce these investments within a strategic context that provides a demonstrable link to competitive and performance requirements otherwise, investments risk becoming “flavours of the month” rather than building blocks that contribute to the development of key organisational capabilities. This approach also helps to ensure that firms introduce interventions using a structured planning process, thereby avoiding resource crises and the confusion that can be created by an excessive number of fragmented interventions.
VITA:

October 23, 1956  Born, Geelong Australia
1978  B. Eng (First Class Honours), Deakin University, Victoria, Australia
1981  M. Eng Sc (IE), University of NSW, NSW, Australia
1981 - 1982  Senior Maintenance Engineer, Shell Refinery, Corio, Australia
1983 - 1986  Senior Development Engineer, Shell Refinery, Singapore
1987 - 1989  Electrical Engineering Manager, Shell Refinery, Corio, Australia
1990 - 1992  Instrument/Electrical Engineering Manager, Shell Refinery, Corio, Australia

Publications Produced During The Course Of This Research:


FIELDS OF STUDY

MAJOR FIELD : Manufacturing Management
MINOR FIELDS : Best Practice, Change Management, Total Quality Management
# Table Of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
</tr>
<tr>
<td>VITA</td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xiv</td>
</tr>
</tbody>
</table>

## CHAPTER

1. **INTRODUCTION**
   1.1 INTRODUCTION .......................................................................................................... 1
   1.2 THE RESEARCH PROBLEM ............................................................................................... 1
   1.3 THE RESEARCH FRAME: INTEGRATED MANUFACTURING (IM) ............................................ 3
   1.4 PRIOR RESEARCH: IM FACETS, ORGANISATIONAL AND HUMAN RESOURCE INVESTMENTS AND PERFORMANCE
   1.5 PROBLEM STATEMENT, DEVELOPMENT OF RESEARCH PROPOSITIONS AND MANAGERIAL INSIGHTS
      1.5.1 Propositions Related to Employee Performance and Manufacturing Performance ... 9
      1.5.2 Propositions Related to IM Facets and Performance ........................................ 10
      1.5.3 Propositions Related to IM Facets and Practices ............................................. 13
      1.5.4 Propositions Related to IM Facets, Practices and Performance ......................... 14
   1.6 ORGANISATION OF THIS STUDY ...................................................................................... 18
   1.7 CHAPTER SUMMARY ...................................................................................................... 19

2. **REVIEW OF THE LITERATURE**
   2.1 INTRODUCTION .............................................................................................................. 21
   2.2 ADVANCED MANUFACTURING TECHNOLOGY (AMT): A DEFINITION ................................... 21
   2.3 SOFT AND HARD AMT .................................................................................................... 22
   2.4 LITERATURE DEVELOPMENT TAXONOMY ....................................................................... 23
   2.5 EARLY RESEARCH ......................................................................................................... 29
   2.6 ECONOMY OF SCALE vs ECONOMY OF SCOPE ................................................................ 29
   2.7 HARD AMT’s, ORGANISATIONS AND HUMAN RESOURCES ............................................... 33
      2.7.1 Hard AMT’s and Organisations .............................................................................. 34
      2.7.2 Hard AMT’s and Human Resources ...................................................................... 38
   2.8 HARD AMT’s, BUSINESS ENVIRONMENT AND MANUFACTURING STRATEGY ................. 40
   2.9 TOTAL QUALITY MANAGEMENT (TQM) ......................................................................... 45
   2.10 JUST IN TIME (JIT) .................................................................................................... 49
   2.11 ORGANISATIONAL AND HUMAN RESOURCE INVESTMENTS ........................................ 54
      2.11.1 Teams .................................................................................................................. 58
      2.11.2 Leadership .......................................................................................................... 60
      2.11.3 Articulating a Shared Vision .............................................................................. 61
   2.12 INTEGRATING AMT’s .................................................................................................... 61
      2.12.1 Hard Integration ................................................................................................ 62
2.12.1.1 General ......................................................... 62
2.12.1.2 Computer Integrated Manufacturing (CIM) ......................... 63
2.12.1.3 Flexible Manufacturing Systems (FMS) ............................ 69
2.12.1.4 Group Technology (GT) ...................................... 71
2.12.1.5 Measures of Integration ..................................... 72
2.13 SOFT INTEGRATION ........................................... 73
2.14 PILLARS OF EXCELLENCE .................................... 78
2.15 WORLD CLASS MANUFACTURING .................................. 80
2.16 BEST PRACTICE .................................................. 83
2.17 INTEGRATED MANUFACTURING .................................. 86
2.18 JUSTIFICATION OF AMT INVESTMENTS ............................ 88
2.19 LIMITATIONS OF THE LITERATURE .................................. 89
2.20 CHAPTER SUMMARY ............................................ 92

3. RESEARCH METHODOLOGY
3.1 INTRODUCTION .................................................... 94
3.2 PHILOSOPHICAL BASIS FOR RESEARCH DESIGN ........................ 94
3.3 QUANTITATIVE METHODOLOGY ................................. 96
   3.3.1 Survey Instrument and Administration ......................... 96
   3.3.2 Sample ...................................................... 99
   3.3.3 Respondent Fatigue ........................................ 99
   3.3.4 Data Preparation ........................................... 100
      3.3.4.1 Data Preparation Stage 1: Measures ...................... 100
      3.3.4.1.1 IM Facets ................................................. 100
      3.3.4.1.2 Employee Performance .................................. 101
      3.3.4.1.3 Manufacturing Performance ............................ 102
      3.3.4.1.4 Practices (Organisational and Human Resource Investments) .................. 103
   3.3.4.2 Data Preparation Stage 2: Treatment of Missing Responses ... 105
   3.3.4.3 Data Preparation Stage 3: Data Checks .................... 106
      3.3.4.3.1 Data Assumptions - General ............................ 106
      3.3.4.3.2 Data Assumptions - Multiple Regression ............... 109
      3.3.4.3.3 Data Assumptions - MANOVA .......................... 112
      3.3.4.3.4 Data Assumptions - Discriminant Analysis ........... 113
   3.3.5 Validity and Reliability Considerations ...................... 114
      3.3.5.1 Validity: Construct Validity, Convergent Validity and Discriminant Validity 114
      3.3.5.2 Factor Reliability ....................................... 115
   3.3.6 Limitations - Quantitative Research .......................... 116
3.4 QUALITATIVE RESEARCH ........................................ 123
   3.4.1 Research Questions ....................................... 123
   3.4.2 Participant Qualification/Selection and Sample Size Development .................. 124
   3.4.3 Case Research Process .................................. 125
      3.4.3.1 Step 1: Preparation .................................. 127
      3.4.3.2 Step 2: Interviews .................................... 127
      3.4.3.3 Step 3: Preparation of Draft Report .................... 127
      3.4.3.4 Step 4: Final Report ................................ 128
   3.4.3 Limitations - Qualitative Research .......................... 128
3.5 CHAPTER SUMMARY ............................................ 129

4. RESULTS OF QUANTITATIVE ANALYSIS
4.1 INTRODUCTION ............................................... 131
4.2 SUMMARY STATISTICS ......................................... 135
   4.2.1 AMT ...................................................... 145
5. RESULTS OF QUALITATIVE ANALYSIS

5.1 INTRODUCTION...........................................................................190
5.2 CHANGE DRIVERS AND CHANGE ENVIRONMENT.........................199
5.3 MANUFACTURING STRATEGY AND CHANGE PROCESS DESIGN........207
  5.3.1 Issue No 1 The level of employee involvement..............................219
  5.3.2 Issue No 2 Integration of Manufacturing Strategy and the Change Process.219
  5.3.3 Issue No 3 The degree of connection between Business Objectives and Change Goals 220
  5.3.4 Issue No 4 The degree of connection between Key Decisions and the Change Plan ....221
  5.3.5 Issue No 5 The design of the Change Process ..............................222
5.4 THE ACTUAL CHANGE PROCESS..................................................222
  5.4.1 Case No 1: Kellogg ..............................................................225
    5.4.1.1 Consultative Committee ..................................................225
    5.4.1.2 Benchmarking ..............................................................227
    5.4.1.3 Management Presentation .................................................228
    5.4.1.4 AMT ............................................................................230
    5.4.1.5 TQM ............................................................................231
    5.4.1.6 JIT ...............................................................................233
    5.4.1.7 Establishment of Work Organisation Teams ..........................234
5.4.2.1 Stage 1: Communicating the need for change and developing relationships ........................................... 242
5.4.2.2 Stage 2: Activity 1 - Enterprise Agreement ......................................................................................... 244
5.4.2.3 Stage 2: Activity 2 - Site Consultative Committee ............................................................................. 245
5.4.2.4 Stage 2: Activity 3 - Retrenchments ................................................................................................. 245
5.4.2.5 Stage 2: Activity 4 - Organisational Restructuring ............................................................................ 246
5.4.2.6 Stage 2: Activity 5 - Benchmarking .................................................................................................. 247
5.4.2.7 Deteriorating Business Environment ............................................................................................... 248
5.4.2.8 Evaluation of Supply Chain Management ........................................................................................ 248
5.4.2.9 Implementation of Supply Chain Management .................................................................................. 251
5.4.2.10 Continuous Flow Manufacturing .................................................................................................... 251
5.4.2.11 Procurement and Distribution ......................................................................................................... 254
5.4.2.12 Supply and Operations Planning .................................................................................................... 256
5.4.3 Case No 3: South Pacific Tyres ............................................................................................................. 257
5.4.3.1 Organisational Effectiveness Framework .......................................................................................... 259
5.4.3.2 Technology ........................................................................................................................................ 260
5.4.3.3 Work Environment ............................................................................................................................ 262
5.4.3.4 Strategic Business Units and Teams ................................................................................................ 262
5.4.3.5 Leadership ......................................................................................................................................... 263
5.4.3.6 Occupational Health and Safety ....................................................................................................... 264
5.4.3.7 Management Systems ...................................................................................................................... 265
5.4.3.8 Operator Selection Process .............................................................................................................. 266
5.4.3.9 Training and Skill Formation ........................................................................................................... 266
5.4.3.10 Literacy and Numeracy Training .................................................................................................... 268
5.4.3.11 Benchmarking and Measurement ................................................................................................... 268
5.4.3.12 Resistance to Change and Union Involvement ............................................................................ 269
5.4.3.13 Employee Involvement, Consultation and Contribution ................................................................. 272
5.5 OUTCOMES OF THE CHANGE ACTIVITY ......................................................................................... 273
5.6 BARRIERS TO CHANGE ....................................................................................................................... 281
5.7 CHAPTER SUMMARY ............................................................................................................................. 286

6. DISCUSSION

6.1 INTRODUCTION ......................................................................................................................................... 290
6.2 DISCUSSION: QUANTITATIVE ANALYSIS ............................................................................................. 290
6.2.1 Employee and Manufacturing Performance .......................................................................................... 291
6.2.2 AMT, JIT, TQM and Performance - General ...................................................................................... 293
   6.2.2.1 AMT ............................................................................................................................................... 293
   6.2.2.2 TQM ........................................................................................................................................... 302
   6.2.2.3 JIT ............................................................................................................................................... 304
6.2.3 AMT, JIT, TQM and Practices ............................................................................................................. 305
6.2.4 AMT, JIT, TQM, Practices and Performance ....................................................................................... 308
6.3 DISCUSSION: QUALITATIVE ANALYSIS ............................................................................................. 316
6.3.1 General Observations - Implementation of Change Activities ............................................................. 316
6.3.2 IM Facet and Practice Investments and Improved Competitiveness .................................................... 318
6.4 CHAPTER SUMMARY ................................................................................................................................ 323

7. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

7.1 INTRODUCTION ......................................................................................................................................... 326
7.2 RESEARCH OVERVIEW ............................................................................................................................ 326
7.2.1 Proposition Set - Lens of Enquiry (Chapter 1) ....................................................................................... 326
7.2.2 Literature Review (Chapter 2) ................................................. 327
7.2.3 Methodological Considerations (Chapter 3) .................................................. 329
7.2.4 Quantitative Analysis (Chapter 4) .......................................................... 330
7.2.5 Qualitative Analysis (Chapter 5) .......................................................... 332
7.2.6 Discussion (Chapter 6) ................................................................. 333
7.3 RESEARCH CONTRIBUTIONS .............................................................. 335
  7.3.1 Empirical Support For Conceptual Theories ........................................... 335
  7.3.2 Research Methodology ............................................................................ 336
  7.3.3 Measurement and Scales ........................................................................ 338
  7.3.4 Theory Development .............................................................................. 338
  7.3.5 Managerial Insights .............................................................................. 343
  7.3.6 Limitations and Suggestions for Future Research .................................... 343
7.4 CONCLUSION ......................................................................................... 346
7.5 CHAPTER SUMMARY ............................................................................. 347

BIBLIOGRAPHY ......................................................................................... 349
### LIST OF FIGURES

**CHAPTER 1.**

- Figure 1.1  AMT Taxonomy Showing The Relationship To IM Facets

**CHAPTER 2.**

- Figure 2.1  Framework For Literature Review
- Figure 2.2  The Product - Process Matrix
- Figure 2.3  Operationalisation of JIT
- Figure 2.4  An Overview of JIT Approach To Manufacturing
- Figure 2.5  Elements of CIM (Fogarty et al)
- Figure 2.6  CIM Framework As Used By Arthur D. Little Inc.
- Figure 2.7  Elements of CIM (Slatter and Carvin)
- Figure 2.8  Elements of CIM (Heizer)
- Figure 2.9  Pillars of Manufacturing Excellence

**CHAPTER 3.**

- Figure 3.1  Best Practice Manufacturing Model

**CHAPTER 5.**

- Figure 5.1  Model For Analysis Of Qualitative Data
LIST OF TABLES

CHAPTER 2

Table 2.1 Advanced Manufacturing Technologies - Definitions
Table 2.2 Linkage Mechanisms - Soft Integration

CHAPTER 3.

Table 3.1 Questions Related To Each Factor (Including Factor Loadings)
Table 3.2 Overview of ACBP Demonstration Program

CHAPTER 4.

Table 4.1 Proposition Set
Table 4.2 Summary Statistics - Scale Responses
Table 4.3 Summary Statistics - Means, Standard Deviations, Minimums and Maximums
Table 4.4 Summary Statistics - Continuous Variables
Table 4.5 Correlation Matrix - IM Facets, Practices, Employee Performance and Manufacturing Performance
Table 4.6 IM Facets, Cross Products, Employee Performance and Manufacturing Performance - Results Of Multiple Regression Analysis
Table 4.7 JIT, TQM, Employee Performance and Manufacturing Performance - Results Of Multiple Regression Analyses For Weak, Average and Strong AMT Environments
Table 4.8 Mean Values Of IM Facets As A Function Of Employee and Manufacturing Performance Environment
Table 4.9 Mean Values Of Employee Performance and Manufacturing Performance As A Function Of IM Facet Environment
Table 4.10 IM Facets and Manufacturing Performance - Results Of Multiple Regression Analyses For Different Employee Performance Environments
Table 4.11 Practices and IM Facets - Results Of Multiple Regression Analyses
Table 4.12 Adding Practices As An Additional Step To The Regression Equations Of Table 4.6 - Results Of Multiple Regression Analyses
Table 4.13 Practice Means and Aggregate Practice/IM Facet Associations As A Function Of Employee Performance and Manufacturing Performance Environments
Table 4.14 Correlations Between IM Facets, Employee Performance and Manufacturing Performance As A Function of Practice Environment
Table 4.15 IM Facets and Employee Performance - Results Of Multiple Regression Analyses For Different Key Practice Environments
Table 4.16 IM Facets and Manufacturing Performance - Results Of Multiple Regression Analyses For Different Key Practice Environments
Table 4.17 IM Facets, Practices And Manufacturing Performance - Results Of Multiple Regression Analyses For Weak, Average and Strong Employee Performance Environments
Table 4.18 IM Facets, Practices And Employee Performance - Results Of Multiple Regression Analyses For Weak, Average and Strong Manufacturing Performance Environments
Table 4.19 IM Facets, Practices And Manufacturing Performance: Results Of Discriminant Analyses For Weak, Average and Strong Manufacturing Performance Environments
Table 4.20 IM Facets, Practices And Employee Performance: Results Of Discriminant Analyses For Weak, Average and Strong Employee Performance Environments
Table 4.21 JIT, TQM, Practice, Employee Performance and Manufacturing Performance Means As A Function Of AMT Environment
Table 4.22 JIT, TQM, Practices And AMT: Results Of Discriminant Analysis
Table 4.23 JIT, TQM, Practices, Employee Performance And Manufacturing Performance: Results Of Multiple Regression Analyses For Weak, Average and Strong AMT Environments
Table 4.24 Summary Of Key Findings.

Note: Dependent Variables denoted in bold.

CHAPTER 5.

Table 5.1 Case Vignettes
Table 5.2 Change Drivers And Change Environment
Table 5.3 Mission And Core Values Statements (examples)
Table 5.4 Change Models (examples)
Table 5.5 Elements Of The Change Processes At Each Site
Table 5.6 Major Events In Kellogg’s Change Process
Table 5.7 Major Events In Fibremaker’s Change Process
Table 5.8 Major Events In South Pacific Tyre’s Change Process
Table 5.9 Quantitative Outcomes
Table 5.10 Qualitative Outcomes
Table 5.11 Barriers To Change
Table 5.12 Principle/Contributory Barriers And their Effects

CHAPTER 7.

Table 7.1 Key Findings: Quantitative Analyses
Table 7.2 Key Findings: Qualitative Analyses
CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces the subject of this dissertation: the relationship of technological, organisational and human resource investments, commonly referred to as Best Practices, to performance. The chapter is organised into 7 sections. Section 1.2 describes the field of study and addresses the issue of why this topic is important. Different researchers have approached this topic from different perspectives and Section 1.3 describes the research frame adopted in this study. Section 1.4 provides a brief insight into some of the previous research that has been performed in this area. Section 1.5, the largest section, defines the purpose of this study in the form of a problem statement and proposition set. The logic underpinning each proposition is also described. Section 1.6 discusses the organisation of material in this dissertation and Section 1.7 provides a summary of the material presented in this chapter.

1.2 The Research Problem

Decisions by governments during the 1980’s have irrevocably committed Australian manufacturing firms to competing for customers against the best enterprises in the world. (Business Council of Australia, 1993). These decisions include the elimination of protective tariffs, the elimination of import quotas, the deregulation of the labour market and the introduction of incentives for business development, workplace reform and export (Bell, 1991, Stewart, 1991, Vandstone, 1994). As Australian manufacturing becomes increasingly integrated into the global marketplace, firms are recognising the need to become internationally competitive in order to secure their future. Moreover, the pressure for change is occurring on many fronts.

Customers are demanding improvements in quality, responsiveness and cost. International competitors are entering existing domestic markets and delivering rapid and continuous streams of improvements in both products and services. Employees are demanding more satisfying work, broader career paths, better wages and conditions and a greater input into issues that affect them. Employers are moving beyond the demarcation and restrictive work practice mindset of the 1980’s and recognising major deficiencies in their workplace cultures. Through regulatory agencies and legislation, governments are reflecting changing societal attitudes and expectations in areas such as equal opportunity, the management of the environment and occupational health and safety. As protective tariffs are phased out, firm profits are reducing and shareholders are demanding improved returns on investment. As markets fragment, product variety and responsiveness to order are becoming increasingly important. New technologies are affecting not only products, markets and
industries but the very nature and form of the work performed. The worldwide economic
downturn of the early 1990’s has forced many firms to seek solutions for maintaining viability
in a climate of lower profit margins. Mergers and acquisitions have become commonplace and
as a result many firms have inherited heavy debt burdens and incompatible organisational
cultures and work practices. Moreover, in the future as the dynamics of the business
environment continue to accelerate these pressures for change are expected to further
increase (Australian Graduate School of Management, 1990, Australian Council of Trade

Australian manufacturing is not unique. American manufacturing firms are confronted
with similar challenges (Hayes and Wheelwright, 1984, Hayes, Wheelwright and Clark, 1988,
are transforming to a new paradigm of, and rediscovering the power that comes from,
Many of these firms are adopting one or more of a growing number of improvement programs,
or soft technologies such as TQM (Total Quality Management), JIT (Just In Time),
benchmarking and the ubiquitous team approach and whilst some improvement efforts have
been successful, many, according to a number of recent surveys, have not (Hayes and Pisano,
1994). Firms are also experiencing high failure rates with hard Advanced Manufacturing
Technologies (hard AMT’s) such as Computer Aided Drafting (CAD), Computer Aided
Manufacturing (CAM) and Flexible Manufacturing Systems (FMS). According to a recent study
by Saraph and Sebastian (1992), failure rates for these technologies exceed 50%.

These high failure rates lend clear and unequivocal support to the need for rigorous
research that addresses the issues of “what works and why”. However, previous studies have
typically concentrated on a particular soft or hard technology even though there is considerable
evidence to suggest that investments are interdependent, tend to appear in combination and
therefore should be analysed as an integrated system (Australian Manufacturing Council,
limited research perspectives can result in the effects of particular investments being upwardly
biased (Huselid, 1995).

Previous researchers have explored two key interdependency themes: the need for
hard technological investments to be accompanied with soft technological investments (Gold,
1982, Goldhar and Jelinek, 1985, Wall, Martin, Clegg and Jackson, 1990, Zairi, 1993) and the
interrelationships between various soft technological investments, for example TQM and JIT,
JIT and teams, TQM and planning, benchmarking and planning, empowerment and skills
development (Australian Manufacturing Council 1994A, 1994B, Flynn, Sakakibara and Schroeder, 1995, Dow, Samson and Ford, 1996). In this research we embrace this characteristic of interdependency, using the bundle of soft and hard technologies defined as Advanced Manufacturing Technology (AMT) as the unit of analysis. More specifically, we define AMT as "the integrated system of technological, organisational and human resource investments applied to the total value chain to develop order winning capabilities and/or achieve certain manufacturing goals." In general, whether change processes emphasise technological, organisational or human resource aspects of AMT, or some combination, there is a dearth of empirical research work in this field and therefore a lack of proven frameworks with which to guide the improvement process.

The compelling business and organisational imperatives for change, when coupled with the plethora of recent hard and soft AMT developments, scarcity of empirical works in the field and the number of failures observed, have left many questions unanswered. Not surprisingly, managers have expressed the need for practical guidance to assist in the development and implementation of AMT's. Key questions frequently asked include the following:

- To what extent are AMT investments associated with the development of a committed and motivated workforce? To what extent are AMT investments associated with improved manufacturing performance? More specifically, what AMT investments are key to obtaining sustainable improvements in manufacturing performance?

- Do AMT investments produce improvements in competitiveness? If so, how?

- To what extent are AMT investments interdependent and what specific investments should be introduced in combination? Further, is there a preferred “sequence” of change activities?

- Are AMT investments interactive? If so, are the interactive effects “significant” in comparison to the main effects?

By analysing the practices and performance of over 1000 Australian and New Zealand manufacturing firms and the experiences of twelve major Australian manufacturers involved in Best Practice programs this research will attempt to address some of these knowledge voids.

1.3 The Research Frame: Integrated Manufacturing

Hard AMT, TQM and JIT are key elements of the approach taken by firms to pursue manufacturing excellence (Dean and Snell, 1991, Ramsey, Samson and Sohal, 1991).
Moreover, the joint application of these three technologies has been reported as changing the entire manufacturing function (Schonberger, 1986, Gunn, 1987). Mortimer (1985), has defined the combination of these technologies as Integrated Manufacturing (IM). In IM, technologies work in concert to change the way goods are produced and people are managed. IM involves a streamlined flow of automated, value added activities, uninterrupted by moving, storage or rework. All functions are closely linked and employees share the common goal of introducing a stream of improvements in cost, quality, and lead time. The relationship between IM and AMT is represented diagrammatically in Figure 1.1. Many different definitions have been ascribed to hard AMT, JIT and TQM. These definitions are discussed in detail in Chapter 2 and the specific set of questions used to assess these variables in this research are discussed in Chapter 3.

Hard AMT is the generic term given to the range of systems and technologies that support world class manufacturing (Dean and Snell, 1991). It is claimed that the adoption of these techniques can facilitate the elimination of barriers between functions and production stages, improve employee productivity and morale and improve the manufacturing outcomes of quality, flexibility, responsiveness and cost (Balan, 1995). The systems and technologies are complex and include Computer Aided Drafting, Computer Aided Engineering, Flexible Manufacturing Cells, Computer Numerically Controlled Machines, lasers, robots, automatic inspection systems and Local Area Computer Networks.

JIT has been defined as a production strategy based on two fundamental principles: the elimination of waste and a high regard for people (Schonberger, 1986). Its name derives from the practice of receiving or producing each raw material or subcomponent “just in time” for it to be used in the next stage of production. Some of the most important JIT practices are product simplification through parts rationalisation, frequent delivery from a limited number of suppliers, tight coupling of process, pull production, visual control, shortened changeover times, small lot sizes, multiskilled workers, cellular manufacturing and effective preventative maintenance (Monden, 1983; Sakakibara, Flynn and Schroeder, 1990, Ramsey Sohal and Samson, 1990). As a result, JIT can improve yield, flexibility, process control and customer responsiveness.

TQM has been defined by a few basic principles: doing things right first time, striving for continuous improvement and fulfilling customer needs (Harrington, 1987) as well as a number of associated practices. For example, making quality the responsibility of each and every employee, working with suppliers to improve the quality of raw material and having well established methods to measure the quality of goods and services. A number of techniques (eg
Figure 1.1

AMT Taxonomy Showing The Relationship To IM Facets

<table>
<thead>
<tr>
<th>Hard AMT</th>
<th>Soft AMT</th>
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<tbody>
<tr>
<td>• Design based technologies (eg. CAD, CAE)</td>
<td>• Organisational / Human Resource Management</td>
</tr>
<tr>
<td>• Manufacturing based technologies (eg. CAM, FMS)</td>
<td>• Employee Development Practices (eg. Recruitment, Progression, Skills)</td>
</tr>
<tr>
<td>• Administrative Technologies (eg. EDT, EMAIL)</td>
<td>• Work Environment Development Practices (eg. Benchmarking Teams, Planning)</td>
</tr>
</tbody>
</table>

Denotes Integrated Manufacturing (IM)
Statistical Process Control) are associated with TQM and the specific set of practices used varies substantially across sites (Sullivan, 1986).

Clearly each facet of IM can effect the nature of work and demands placed on employees. IM increases the skills required of employees, the amount of discretion they must be accorded and the impact they have on production (Helfgott 1988, Majchrzak, 1988, Warnecke, 1988). Consequently, as the potential contribution of employees in IM settings is greater than in traditional plant, employees are attracted to making additional investments in their human resources and organisations (Samson, Sohal and Ramsey, 1991). These investments include human resource management practices eg. selection, training, development and remuneration (Snell and Dean, 1992) in addition to other organisational investments that help to create work environments that enhance employee contributions, eg. organisational re-design, job re-design, business process re-engineering, team development and benchmarking (Bowen and Lawler III, 1992, Australian Manufacturing Council, 1994A, 1994B, Schonberger, 1994). Henceforth, to simplify terminology, we refer to these additional organisational and human resource investments as practice investments.

Pfeffer (1992), Schonberger (1986 and 1994), Stalk (1991), and Stalk, Evans and Shulman (1992), have argued the need for firms to invest in their employees and organisations from the perspective of enhancing business competitiveness. These researchers and practitioners believe that success in the emerging manufacturing paradigm will be largely determined by organisational and employee capabilities and not the traditional structural set of attributes such as markets, products, economy of scale, geography and customers. These findings are also supported by Walton (1985), who found major changes in style and content of management processes in superior manufacturing operations. Many other researchers and practitioners are also subscribing to this view as demonstrated by the increasing volume of literature devoted to human resource based origins of competitive advantage.

1.4 Prior Research : IM, Organisational and Human Resource Investments and Performance

Little, if any research has investigated the relationship between IM facets and performance and the impact of practice investments on this relationship. Research to date has mainly relied on case studies that have focused on single IM elements, in particular, aspects of hard AMT. Although these studies have contributed to researcher's understanding of the processes associated with the selection, introduction and evaluation of IM facets in addition to generating and testing various hypotheses, they are not without their limitations. Due to issues of investment interdependency this approach is theoretically deficient; due to issues of sample size the lessons learnt cannot necessarily be generalised and the approach is therefore practically deficient. Another limitation of the extant research relates to bias. There exists a
preponderance of cases documenting success with relatively few documenting failures. It is therefore extremely difficult to contrast and evaluate the considerations that differentiate success from failure. Although case studies have generated various theories concerning the most effective means of implementing and using various investments, the results have also frequently presented idiosyncratic or conflicting findings (Australian Manufacturing Council, 1994A, Balan, 1995, Majchrzak, 1988, Manufacturing Studies Board 1988, Terziorski, 1996).

In terms of specific contributions, Fossum (1986), Ettlie (1986, 1988, 1990), Merideth (1987, 1990), Voss (1988), Owen (1990) and Balan (1995) have all contributed to identifying sets of organisational and human resource factors that impact on the degree to which hard AMT investments are successful. There is a growing body of evidence that suggests that the adoption of radically new technologies does not lead to economic success, at least in the short term (Davis, 1986). Further, since most firms buy hard AMT “off the shelf”, it is difficult to protect its advantages from imitation and circumvention. Ettlie and Reza (1992), have also suggested that a key outcome of hard AMT investments is their ability to create a unique occasion for organisational restructuring and the redesign of work. The literature is resplendent with case studies documenting firm’s TQM experiences (Luchs, 1986, Trevor, 1986, Lascelles, 1988, AQF, 1991, Young, 1992, Hill, 1993, Juran, 1993, Samson, 1993, Szulanski, 1993). Whilst the majority of this research does conclude that TQM adds some value (Powell, 1995) some researchers and practitioners have reported failures (Naj, 1993, Fuchsb erg, 1992, 1993, Schaffer and Thomson, 1992). A similar plethora of articles exist detailing firm experiences with JIT. The propensity to write about the technical aspects of JIT implementation highlights the absence of essential and instructive literature on human resource management aspects of the technology (Ramsey, Sohal and Samson, 1990). The interplay between industrial relations and JIT is the notable exception having received considerable attention (Wilkinson and Oliver, 1989 Mortensen, 1988, Linch, 1989 Tuckey, 1989).

A large component of the empirical research in this area is concerned with the relationships between various AMT investments and business and manufacturing performance. Much of the criticism directed toward this research is associated with the lack of standardised terminology and reliable scales with which to measure key constructs (Adam and Swamidass, 1989, Cleveland and Schroeder, 1989, Merideth, Raturi, Amoako-Gyampah and Kaplin, 1989 and Flynn, Sakakibara, Schroeder, Bates and Flynn, 1990). To demonstrate some of these concerns consider TQM, which, despite the thousands of articles in the business and trade press, remains a hazy and ambiguous concept (Bowen and Dean, 1994). Researchers such as Bain (1982), Dean and Snell (1991), Powell (1995), and Ross (1993), have ascribed different definitions to TQM reflecting a broad range of research objectives and theoretical perspectives. In the absence of a clearly defined construct and accompanying set of measures and scales, knowledge development is sporadic and fragmented rather than coherent and cumulative.
Moreover, in respect to empirical TQM research, most of the studies have been conducted by consulting firms and quality associations with vested interests in their outcomes and most do not conform with generally accepted standards of academic rigour (Powell 1995).

In respect to empirical work that uses the IM construct, Dean and Snell (1991), and Snell and Dean (1992 and 1994), have undertaken three key studies. In their first contribution, Dean and Snell (1991), examined the relationship between IM facets and job design and found that performance, size and external control did not moderate this relationship. Snell and Dean (1992), subsequently investigated the relationship between IM facets and various human resource management practices including staff selection, training and development appraisal for operations, quality and production control employees and found a number of relationships to be positive and significant. In their final contribution, Snell and Dean (1994), examined the relationship between employee remuneration strategies and IM facets where aspects of job design (eg. task interdependence) and organisational context (eg. unionisation) were considered as covariates. They found virtually no direct effects. Whilst these studies have provided valuable insights into the relationships between IM facets and various practices, they have not evaluated the relationships between IM facets, both individually and in combination, and manufacturing performance. The research of Balan (1995), investigated aspects of the relationship between IM facets and performance. However, the sample frame was limited to 35 firms, the research was biased toward sites with significant hard AMT investments (all firms examined were from the computer, telecommunications, aerospace and pharmaceutical sectors) and practice investments were not considered. One end goal of this research is to examine the relationships between IM facets, practices and performance and therefore we seek to build upon the work of Balan and Snell and Dean.

Recently (Australian Manufacturing Council, 1994A, Flynn et al, 1994, Reger et al, 1994, Powell, 1995, Redman 1995, Dow, Samson and Ford, 1996, Terziovski, 1996) a number of studies have considered the relationship between various practices, commonly referred to as Best Practices, and performance. With the exception of the work of Dow et al, sample populations have been small (< 30). Furthermore, these studies have generally concentrated on the analysis of select IM elements (eg TQM) and also produced inconsistent results further highlighting the need for additional research. For example, the AMC (Australian Manufacturing Council, 1994A) found a relatively strong positive correlation to exist between most practices and performance. Dow, Samson and Ford (1996) found the correlation to be marginal and Redman, 1995 found a negative correlation to exist. Similarly the AMC (Australian Manufacturing Council, 1994A) reported benchmarking as “the single practice that most clearly separates leaders from laggards” (Australian Manufacturing Council, 1994A, pp. 39). Terziovski (1996), found benchmarking to have no statistically significant effect on manufacturing performance.
1.5 Problem Statement, Development of Research Propositions and Managerial Insights

Given the plethora of technological, organisational and human resource investments made by firms in response to changes in the business environment:

"Do firms that invest in IM facets (i.e. hard AMT, TQM and JIT) have better employee performance and manufacturing performance than those firms who do not? If so, how do investments in IM facets result in improved performance and competitiveness?"

In order to address the first part of this research question a number of research propositions were developed which were tested in empirical work. These propositions were grouped into four key areas:
1. Relationships between employee performance\(^1\) and manufacturing performance\(^2\).
3. Relationships between IM facets and practices\(^3\).

Groups one to four are developed into a number of specific research propositions in the sections below.

Hayes and Pisano (1994, pp.78), remarked that "the companies that transform manufacturing organisations into sources of competitive advantage can harness various improvement programs to the broader goal of selecting and developing unique capabilities."

The second part of the problem statement is addressed to this issue. A suite of 12 detailed case studies is performed to gather insights on the complex sets of linkages between AMT investments, order winning capabilities and improved performance and competitiveness. The research design employed in this research is discussed in considerable detail in Chapter 3.

1.5.1 Proposition Related To Employee Performance and Manufacturing Performance

Many researchers and practitioners have argued that superior employee performance is important to attaining superior manufacturing performance and competitiveness and as the

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\(^1\) The employee performance construct is defined in Chapter 3. It evaluates aspects of employee performance that include morale, productivity, industrial disputation, and employee skills.

\(^2\) The manufacturing performance construct is defined in Chapter 3. It evaluates aspects of manufacturing performance that include customer satisfaction, cash flow, unit cost and industrial accidents.

\(^3\) Seven practices are considered in this research: ability to change, benchmarking, HR Management, leadership, planning, training and teams. Practice constructs are defined in Chapter 3.
dynamics of competition continue to accelerate, its importance will continue to increase (Prahalad, 1983, Reich, 1990, Stewart, 1990, Stalk, Evans and Shulman, 1992). The implication of this hypothesis is that change technologies such as IM which are based on human resource theories of competitive advantage (Dean and Snell, 1991, Samson, Sohal and Ramsey, 1991) will become increasingly important. Many studies, all be they predominantly case study based, have touched on aspects of this relationship. In studying the practices of 10 manufacturing firms engaged in change processes, the Department of Industrial Relations, 1993, remarked that the development of a co-operative work ethic between management, unions and workers improved workforce productivity and efficiency and improved both the competitiveness and performance of manufacturing firms. The MIT International Motor Vehicle Program demonstrated the strong link between employee productivity and quality performance (Australian Manufacturing Council, 1990). The Innovation Study Commission (Business Council of Australia, 1993) found that changes in workplace culture and employee mindsets "opened the door" to vastly increased opportunities for innovation and improved performance. The Business Council of Australia's detailed study of labour relations (Business Council or Australia, 1989A) concluded that in order for Australian enterprises to become internationally competitive, firms needed to improve employee performance by making significant investments in employee skillsets and the development of participative and co-operative work cultures. In analysing the performance of 12 leading Australian Manufacturing firms, Samson (1991), found that in highly competitive firms the human resource was seen as a central and key aspect of the operational strategy, irrespective of how the firm was trying to compete. Consequently it is to be expected that:

**Proposition 1**
Strong manufacturing performance is positively related to strong employee performance.

1.5.2 Propositions Related To IM Facets (Hard AMT, JIT, TQM) and Performance

Hard AMT provides the opportunity to reduce labour costs, improve process quality and reduce cycle times in addition to improving employee productivity and morale by providing more interesting and meaningful work, more marketable skillsets, a safer working environment and improved opportunities for self development (Penning, 1987, Meredith, 1987). TQM applies tools and techniques such as statistical process control to improve process quality, reduce cost and enhance operational flexibility. By developing practices that improve cooperation, foster teamwork, employee participation and accountability, TQM also contributes to improved morale, productivity and safety performance. TQM has also been reported to improve teamwork and safety and reduce absenteeism and accidents (Redman, 1995). By reducing buffer stocks and rationalising the supplier base, JIT reduces manufacturing costs. By
instilling quality at the source, designing jobs around manufacturing cells and improving the scheduling of work, JIT is also reported to improve productivity, flexibility, employee involvement and morale (Samson, Sohal and Ramsey, 1990). These findings lead to the following propositions:

**Proposition 2.1**
Facets of IM (Hard AMT, JIT, TQM) are positively related to employee performance. That is:
- Hard AMT is positively related to employee performance
- JIT is positively related to employee performance
- TQM is positively related to employee performance

**Proposition 2.2**
Facets of IM (Hard AMT, JIT, TQM) are positively related to manufacturing performance. That is:
- Hard AMT is positively related to manufacturing performance
- JIT is positively related to manufacturing performance
- TQM is positively related to manufacturing performance

JIT, TQM and hard AMT can and do work as stand alone systems but the concept of IM implies that they also work together to unite the goals of manufacturing in a synergistic relationship (Mortimer, 1985, Snell and Dean 1992, Samson, Ramsey and Sohal 1993). For example, hard AMT enables significant improvements in process quality to be achieved as complex machines have the capabilities to achieve and maintain product quality to the strictest tolerance continuously. TQM helps to develop tools and techniques that provide a measurement system for continuous reduction of processing time. JIT also maintains quality during work in progress between workstations as unacceptable parts are not permitted to move to the next workstation for processing. Hard AMT provides for short production cycles ensuring smooth delivery of all finished products from the plant. TQM promotes better co-operation between the supplier and plant to ensure correct delivery of raw materials and components, JIT maintains a synchronised movement of goods from suppliers through the plant and to the final customer thus avoiding delays in delivery and improving customer service. The focus of JIT on lead time forces managers to make changes that improve quality and cost (Schmenner, 1988).

The interactive effects also jointly affect the nature of employee's work. For example, working with JIT in a factory using hard AMT is far more complex than in a traditional plant because JIT must deal with hard AMT's shorter lead times and more complex interdependencies (Gunn, 1987). Similarly the combination of TQM and hard AMT requires more of employees since automated systems demand better quality raw materials without the
opportunity for operator fine-tuning (Hirschhorn, 1984). Therefore the possible combinations of practices require more from employees than the individual practices alone, incrementally increasing the value of employee contributions, the quality of work and the employee performance. Therefore in respect to two and three way interactions between IM cross products:

Proposition 2.3.

The interactive effects of IM (Hard AMT, TQM, JIT) are positively related to employee performance. That is:

- Hard AMT * JIT is positively related to employee performance.
- Hard AMT * TQM is positively related to employee performance.
- TQM * JIT is positively related to employee performance.
- Hard AMT * JIT * TQM is positively related to employee performance.

Proposition 2.4.

The interactive effects of IM (Hard AMT, TQM, JIT) are positively related to manufacturing performance. That is:

- Hard AMT * JIT is positively related to manufacturing performance.
- Hard AMT * TQM is positively related to manufacturing performance.
- TQM * JIT is positively related to manufacturing performance.
- Hard AMT * JIT * TQM is positively related to manufacturing performance.

Hard AMT, TQM, JIT are three manufacturing improvement technologies used extensively to transform manufacturing operations over the last decade strategies (Dean and Snell, 1991, Snell and Dean, 1992, Ramsey, Sohal and Samson, 1993). Although some exceptions are expected, for example, firms operating in monopoly markets or industries, firms employing proprietary technologies within technologically intensive industries, in general, firms that have invested in these technologies are expected to have stronger levels of employee and manufacturing performance and vice versa. Consequently:

Proposition 2.5

Firms weak in all facets of IM (hard AMT, TQM, JIT) exhibit weak employee performance.

Proposition 2.6

Firms weak in all facets of IM (hard AMT, TQM, JIT) exhibit weak manufacturing performance.
Proposition 2.7
Firms strong in all facets of IM (hard AMT, TQM, JIT) exhibit strong employee performance.

Proposition 2.8
Firms strong in all facets of IM (hard AMT, TQM, JIT) exhibit strong manufacturing performance.

As IM facets are underpinned by human resource based theories of competitive advantage, it is expected that firms investing in IM will be more inclined to make accompanying investments in other human resource and organisational areas (Schonberger, 1994) further increasing the value of employee contributions. Consequently, it is expected that the greater the level of investment in IM facets, the greater the contribution of employee performance to manufacturing outcomes.

Proposition 2.9
The stronger the IM facet (hard AMT, TQM, JIT) environment, the stronger the positive association between employee and manufacturing performance.

It is also expected that in weak employee performance environments, characterised by low productivity, poor morale, weak skills and high industrial disputation, IM facets will have less effect on manufacturing performance than in strong employee performance environments.

Proposition 2.10
The stronger the employee performance environment, the stronger the association between facets of IM (hard AMT, TQM, JIT) and manufacturing performance. That is, the stronger the employee performance environment:
- the stronger the association between hard AMT and manufacturing performance.
- the stronger the association between JIT and manufacturing performance.
- the stronger the association between TQM and manufacturing performance.

1.5.3 Propositions Related To IM Facets (Hard AMT, JIT, TQM) and Practices
Each facet of IM can effect the nature of work and the demands placed on employees (Pietro and Schremser, 1987). More specifically, as the IM construct is underpinned by human resource based theories of competitive advantage (Dean and Snell, 1991), it is expected that firms investing in IM facets will be more inclined to make additional investments in other human resource and organisational areas (Schonberger, 1994). Some prior research has
provided partial support for this proposition finding that IM facets require greater conceptual, analytical and problem solving skills than did previous manufacturing paradigms (Helfgott, 1988, Samson, Sohal and Ramsey, 1993, Kern and Schumann, 1990, Schmenner, 1988, Wilkinson, 1983). Consequently, it is expected that:

Proposition 3
Investments in IM facets are positively associated with practice investments. That is:

- Hard AMT is positively associated with practice investments.
- JIT is positively associated with practice investments.
- TQM is positively associated with practice investments.

1.5.4 Propositions Related To IM Facets (Hard AMT, JIT, TQM), Practices and Performance

Practice investments not only create work environments that support IM facets but also, both individually and in combination, improve manufacturing and employee performance. Consider investments in strategic management processes. Numerous researchers have provided both conceptual and empirical support for the pivotal role of manufacturing strategy in firm success (Skinner, 1969, Buffa, 1984, Hayes and Wheelwright, 1984, Schroeder, Anderson and Cleveland, 1986, Gunn, 1987, Roth and Miller, 1992, Hill, 1993). By facilitating alignment between manufacturing and business goals and providing a framework with which to direct key decision making, an effective manufacturing plan and planning process are key success factors (Hill, 1985, Samson, 1991). Other researchers have highlighted the need for a long range orientation and common set of site-wide goals in order to ensure that TQM, JIT and hard AMT investments are successful (Samson, Sohal and Ramsey, 1993, Flynn, Schroeder, Sakakibara, 1994, Balan, 1995). The Australian Manufacturing Council, 1994B also indicated that ineffective planning processes were a key reason why a number of hard AMT installations were found to be idle. Consider also investments in leadership. Empirical work by the Australian Manufacturing Council (1994A), and Powell (1995), has clearly demonstrated the link between firm leadership and manufacturing performance. However, the ability of senior executives to create and sustain customer focus and demonstrate quality values has been inextricably linked to the success of TQM (Ramsey, Samson, Sohal, 1991, American Society for Quality Control, 1993, Redman, 1995). Moreover, Ramsey, Sohal and Samson (1990), identified the ability of managers to build commitment, allocate scarce resources and challenge the way existing work was performed as key factors impacting on the success of JIT. Balan (1995), also found that strong project leadership was the single largest factor critical to the successful implementation of hard AMT.
Similar arguments may be developed for the dependent variable of employee performance. Consider investments in teams. Work teams have been argued to improve employee performance by overcoming issues of employee alienation, poor morale and stagnant productivity (Lawler, 1992, Weisbord, 1987, Wellins, Byham and Wilson, 1991). Work teams have also been considered to give employees a greater sense of ownership and pride in their work, improve communication and co-operation, increase commitment to continuous improvement and increase decision making power (Lawler, 1992, Osborne, Moran, Musselwhite, Zenger and Perrin, 1990, Wellins, Byham and Wilson, 1991). These are characteristics of effective TQM and JIT environments (Samson, 1991, Schonberger, 1986, 1994). Wall, Corbett, Martin, Clegg and Jackson (1990) also found that the effectiveness of hard AMT was enhanced in team based work environments. Consider also investments in employee training. These skills not only contribute to hard AMT, JIT and TQM effectiveness but also facilitate increased employee responsibility, career progression and enhanced marketability leading to increased employee morale and job satisfaction.

Similar arguments may be developed for other practice investments leading to the following propositions:

**Proposition 4.1**

That (after the variance in employee performance due to IM facets has been considered) practices explain additional variance in employee performance.

**Proposition 4.2**

That (after the variance in employee performance due to IM facets has been considered) practices explain additional variance in manufacturing performance.

Although it is expected that most, if not all, practice investments will have some degree of positive association with IM facets, some practice investments are expected to contribute more to the effectiveness of IM facets than others. For example, as discussed earlier, strong strategic planning and leadership practices have been identified as key to the successful implementation of IM facets. Consequently, it is expected that the associations between IM facets and employee performance and IM facets and manufacturing performance will be stronger in environments characterised by strong strategic planning and leadership practices. Other practices such as benchmarking and HR policy are more peripheral to the success of IM facets and are therefore expected to have less impact on the relationships between IM facets and employee performance and IM facets and manufacturing performance. Some firms have also been observed to introduce skills development programs based on the requirement to fulfil training quotas, pursue industry reform agendas or trade off restrictive work practices rather
than contribute to the development of a capability that links to their business or operational needs (Vandstone, 1993). These arguments lead to the following propositions:

Proposition 4.3

Certain practice environments (e.g., planning and leadership) are associated with stronger associations between IM facets and employee performance.

Proposition 4.4

Certain practice environments (e.g., planning and leadership) are associated with stronger associations between IM facets and manufacturing performance.

Under the emergent manufacturing paradigm (Drucker, 1986, Hayes and Wheelwright, 1988, Australian Manufacturing Council, 1994A) exemplar manufacturing performance is increasingly associated with strong employee performance. Consequently, firms with strong employee performance but weak manufacturing performance are expected to be ineffective at linking IM facet investments with practice investments. Conversely, firms with strong manufacturing performance but weak employee performance are expected to be more effective at linking IM facet and practice investments. These latter firms may exhibit relatively weak levels of investment in IM facets and practices but what they do possess is applied effectively. This logic suggests the following propositions:

Proposition 4.5

That the relationship between IM facets (AMT, JIT, TQM) and practices is strongest in environments with weak employee and strong manufacturing performance.

Proposition 4.6

That the relationship between IM facets (AMT, JIT, TQM) and practices is weakest in environments with strong employee and weak manufacturing performance.

It is expected that the manufacturing performance environment will impact on the relationships between IM facets and practice investments and employee performance. For example, firms with strong manufacturing performance are expected to focus on longer time horizons and place more emphasis on the introduction of IM facets and practices which increase long term competitiveness and increase employee performance (Challis and Samson, 1995A). Also, given the direct link between firm profitability and the availability of slack resources for investment, (Huselid, 1995) these firms are also expected to be more disposed to making organisational, human resource and in particular, technological investments.
Conversely, firms with weak manufacturing performance are expected to have weaker linkages between business plans, manufacturing structure and capabilities, attempt too many improvement opportunities (Australian Manufacturing Council, 1994) and place excessive emphasis on short term actions to reduce costs and efficiencies (Skinner, 1984). Investments are therefore expected to have only weak associations with employee performance.

It is expected that the employee performance environment will also impact on the relationships between IM facets and practice investments and manufacturing performance. All IM facets and practice investments are underpinned by human resource based theories of competitive advantage and serve to increase the value of employee contributions to manufacturing performance. Therefore, in weak employee performance environments, it is expected that employee behaviours and mindsets will result in these investments having relatively weak impacts on manufacturing performance. Conversely in work environments characterised by good morale and low industrial disputation, employees are expected to be more receptive to IM facet and practice investments, and as a consequence, the impact of these investments on manufacturing performance is expected to be greater. This logic leads to the following propositions:

**Proposition 4.7.**

The strength of the manufacturing performance environment influences the strength of the associations between IM facet and practice investments and employee performance.

**Proposition 4.8**

The strength of the employee performance environment influences the strength of the associations between IM facet and practice investments and manufacturing performance.

Today, many firms embrace TQM concepts such as customer focus, making quality the responsibility of each and every employee and working with suppliers to improve the quality of raw materials. Consequently, it can be argued that TQM is increasingly becoming a qualifier for doing business rather than discriminator of business performance (Challis and Samson, 1996B). Ramsey, Samson and Sohal (1991), also found some evidence that managers of manufacturing firms implementing TQM “to survive” achieved more benefits than those implementing TQM “to grow and prosper.” These arguments and findings support the following proposition:

**Proposition 4.9**

As the level of manufacturing performance increases, the strength of association between TQM and manufacturing performance decreases.
One theme that consistently runs through the hard AMT literature is that the organisational and human resource issues associated with factory automation have been frequently ignored in the past (Rosenthal, 1984; Clancy, 1986; Balan, 1995). However, there is now increasing recognition that, with the introduction of hard AMT, human capital input changes from manual to intellectual, and includes the need for sophisticated maintenance, scheduling, planning and continuous process improvement (Warnecke, 1988, Samson, 1991). Consequently, it is expected that firms investing in hard AMT will make accompanying investments in organisational and human resource practices. There is also some evidence to support that hard AMT is a “pervasive” technology and effects many different areas of the organisation (Weill, Samson and Sohal, 1991). Hayes and Jaikumar (1988), have likened the introduction of hard AMT to “replacing a car with a helicopter” reflecting the dramatic change in operating paradigm associated with the introduction of this technology. Therefore, hard AMT investments have the potential to create a single focus and common platform from which to implement and integrate other human resource and organisational investments thus increasing their value. These arguments lead to the following propositions:

Proposition 4.10
That stronger hard AMT environments are associated with stronger practice environments.

Proposition 4.11
The stronger the hard AMT environment, the stronger the association between JIT, TQM and practice investments and employee performance.

Proposition 4.12
The stronger the hard AMT environment, the stronger the association between JIT, TQM and practice investments and manufacturing performance.

1.6 Organisation of this study
The remainder of this study is organised into six chapters. Chapter 2 provides a discussion of the literature related to Advanced Manufacturing Technology (AMT) which, as discussed earlier in this study, is defined in its broadest context: “The integrated system of technological, organisational and human resource investments applied to the total value chain to develop order winning capabilities and/or achieve certain manufacturing goals.” The literature review is therefore, by necessity, broad. The literature streams related to hard AMT, JIT and TQM are discussed in considerable detail along with literature that relates to other practice.
(organisational and human resource) investments and three manufacturing excellence paradigms: Pillars of Excellence, Integrated Manufacturing and Best Practice. Chapter 3 examines the methods and processes used to test the propositions and address the questions posed in this study. This chapter includes a discussion of the rationale for applying both qualitative and quantitative methodologies to this research. In essence, quantitative approaches are used to address the question of "what works (it is accepted that causality can be implied but not proven) and qualitative approaches are used to gain insights into "how it works" in addition to assessing some aspects of causality. Chapter 3 also discusses, in considerable detail, a number of issues related to the quantitative analysis. These include: the survey instrument and survey administration, the sample, respondent fatigue, the preparation of the data, the reliability of the measurement scales, content validity, construct validity and limitations. This chapter also discusses the assumptions associated with the use of the various statistical analysis techniques employed in the analysis.

Chapter 4 describes the activities undertaken and the results of, the quantitative analysis. The discussion follows the proposition set structure developed in this chapter. A number of additional analyses were performed as some of the results obtained differed substantially from those expected. Chapter 5 describes the 12 case studies performed to investigate aspects of the relationships between technological, organisational and human resource investments and improved competitiveness and performance. A model is developed to organise the discussion of material. Considerable time is invested discussing firm's rational for change, characteristics of the change environment, the outcomes obtained and the barriers to change. Chapter 6 is concerned with developing detailed insights into the results of the quantitative and qualitative analyses. Key findings are combined from a number of different perspectives to enrich understanding of the behaviour of IM facets (AMT, JIT, TQM) and practice investments and understanding of their relationship to performance. Chapter 7 summarises the work undertaken in this research and considers its contribution. Contributions are examined from the following perspectives: empirical support for conceptual theories, research methodology, measurement scales, theory development, managerial insights, limitations and suggestions for future research.

Finally, each chapter in this dissertation:

- is commenced with an introductory section that defines the purpose of the chapter and describes how material is organised,
- is concluded with a summary of the key points discussed.

1.7 Chapter Summary

This chapter introduces the subject of this dissertation: the relationship of technological, organisational and human resource investments, commonly referred to as Best
Practices, to performance. It was shown that in response to a broad number of pressures for change, manufacturing firms are increasingly making investments in these areas and that a significant number of these investments are not considered successful. Consequently, there is currently intense interest in this subject and with pressures for change expected to further increase into the future, this interest will only increase.

Hard AMT, JIT and TQM were shown to be key ingredients of the change process adopted by many firms. It was described how the combination of these investments, defined as Integrated Manufacturing (IM), has a considerable impact on the nature of work and demands placed on employees and as a consequence firms investing in IM are often predisposed to making practice investments, eg, teams, training and benchmarking. In section 1.4 prior research associated with IM and practice investments was briefly discussed. It was shown that most prior IM research has been concerned with the relationship between IM facets and practices. To this researcher’s knowledge with the exception of the work of Balan (1995), which is limited to insights gained in 35 high technology firms, the relationship between IM facets and performance is largely untested.

The purpose and objectives of this study were formulated in the form of a key research question and detailed set of propositions. Supporting logic was provided for each proposition. The chapter concluded with a brief discussion of the approach taken to the organisation of material in the subsequent chapters.
CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction

This chapter presents a review of the literature on Advanced Manufacturing Technologies (AMT's), including their use within industry. The discussion is organised according to a taxonomy of six attributes which have been identified from a review of in excess of 500 articles. Issues related to the value of AMT investments and factors and issues that facilitate or impede success will be discussed within the various sections. These attributes are:

- the elements of AMT (hard and soft Advanced Manufacturing Technologies),
- the integration of hard and soft AMT elements,
- the business environment, manufacturing strategy and AMT
- organisational adaptations, human resource development and AMT
- manufacturing excellence paradigms and AMT
- the justification process for AMT investments

Each of these attributes has been examined on an individual basis in previous research and is considered to constitute a key area of knowledge development in relation to AMT's. After defining AMT (Section 2.2), hard and soft AMT elements (Section 2.3) and some factors and issues related to the development of the literature (Sections 2.4 to 2.6), the research associated with these attributes is summarised (Sections 2.7 to 2.18). Both theoretical and empirical perspectives are considered. Section 2.19 discusses limitations of the extant literature with Section 2.20 providing a summary of the material discussed in this chapter.

2.2 AMT: A Definition

There have been many differing views about what constitutes AMT. While some researchers have considered AMT from a hardware point of view, others have looked at it from a software perspective. These different perspectives are reflected in the different definitions that have been developed and discussed by various organisations and authors. The Advisory Council for Applied Research and Development (ACARD) in the U.K., defines AMT as "...any new technique, which when adopted, is likely to require a change not only in manufacturing practice, but also in management systems and the manufacturer's approach to the design and production engineering of the product."

Noori (1990), argues that AMT refers to "new technologies which are used directly by the firm in the production of a product (for example, a television set) or in the provision of a service" (for example, a hospital operating room). He also argues that management philosophies (eg. TQM and JIT) are essential components of AMT.
Zeleny (1986), considers AMT to embrace much more than just machines. He identified three important components of a technology which he argues are equally important. They are hardware, software, and brainware. Used in this context, hardware refers to the physical structure and logical layout of the requirement or machinery that is to be used to carry out the required tasks. Software refers to the knowledge of how to use the hardware in order to carry out the required tasks and brainware refers to the reasons for applying the technology in the manner chosen.

Slatter and Carven (1989), also report that National Economic Development Office (NEDO) considers AMT’s to be technological aids which have an impact on:

- Automated parts issue and storage,
- Flexible Manufacturing Systems (FMS),
- Improved assembly and test,
- Computer aided manufacture,
- Computer-aided design and draughting (CAD),
- Computer numerically controlled machining (CNC),
- Computerised production control, and
- Computerised inventory control.

In this work we have developed the following definition for AMT:

“the integrated system of technological, organisational and human resource investments applied to the total value chain to develop order winning capabilities and/or achieve certain manufacturing goals.”

Our definition is unique in that it recognises four essential aspects of AMT. First, AMT includes hardware based technologies (eg. Flexible Manufacturing Systems and Computer Aided Drafting), software based technologies (eg. Just In Time and Total Quality Management), organisational investments (eg benchmarking, teams) and personnel investments (eg. training and development). Second, this definition considers AMT as a system and is therefore concerned with the linkages and interdependencies between the various elements. Third, AMT is concerned with the total value chain. Consequently, the rationalisation of suppliers, reengineering of production processes and development of customer service agreements are all included. Fourth, AMT’s are introduced with the objective of developing key capabilities (eg. continuous improvement of product quality and development of an empowered workforce) and/or achieving specific goals (eg. increase processing yield by 50%, reduce staff strength by 25%). This work will evaluate aspects of the relationship between AMT and performance and therefore assess the degree to which this objective is realised.
2.3 Soft and Hard AMT

In this research we divide AMT's into two areas henceforth referred to as hard AMT and soft AMT. Hard AMT is used to describe a variety of technologies which primarily use computers to control, track or monitor manufacturing activities, either directly or indirectly. In addition, technologies such as bar code scanners and Group Technology (GT), although not directly involving computers, are considered hard AMT because they are closely associated with hard AMT applications. For example, bar code scanners are generally interconnected to a host computer which maintains a database of transactions and GT is generally closely associated with the use of CNC machine tools or FMS. Soft AMT is the term used to describe the various types of manufacturing programs and activities which don't involve the purchase or acquisition of technology or plant and which are commonly referred to as Manufacturing Improvement Programs (MIP's) and Organisational Development Programs (ODP's). MIP's and ODP's differ in specific objectives but similar to hard AMT share the underlying objective of building manufacturing capabilities. TQM, JIT, team development, organisational redesign, award restructuring, concurrent engineering and design for manufacture are all examples of soft AMT. In this research we focus on soft AMT that is based on the principles of employee involvement, commitment and empowerment. Further, this research examines soft AMT in terms of the capabilities that it helps to build rather than the specific mechanics of each program. Hayes and Pisano (1994), support this focus, arguing that most companies “focus on the form and substance of their organisational assets, for example, the mechanics of JIT and TQM - rather than their substance, the skills and capabilities that enable a factory to excel and make it possible for various improvement programs to achieve their desired results.”

2.4 Literature Development Taxonomy

Fig 2.1 provides a pictorial representation of the structure used to review AMT literature. Hard technologies may be grouped by area of application: design/engineering, manufacturing and infrastructure as shown in Table 2.1. This grouping has substantial similarity to that developed by Shani, Grant, Krishnan and Thompson, (1992). In this review, three core soft technologies will be discussed: Just In Time (JIT), Total Quality Management (TQM) and Human Resource Management (HRM). Integration can occur between hard AMT elements, between soft AMT elements or between combinations of hard and soft elements. The appropriate combination of AMT's and manufacturing strategy can facilitate changes in the business environment and constitutes a key area of AMT research. The need for organisational adaptations (structure, roles etc) to accompany the introduction of hard technologies is widely acknowledged as a key issue and is associated with a substantial body of research. In response to widespread and large scale changes within the business environment over the last decade, manufacturing paradigms such as Pillars of Excellence, World Class Manufacturing, Integrated
Figure 2.1 Framework for Literature Review

Hard AMT organisations and human resources

AMT ELEMENTS

<table>
<thead>
<tr>
<th>Hard AMT</th>
<th>Soft AMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design/Eng’ng</td>
<td>TQM</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>JIT</td>
</tr>
<tr>
<td>Support</td>
<td>HRM</td>
</tr>
</tbody>
</table>

AMT INTEGRATION

- Hard integration (eg. CIM, FMS, GT)
- Soft integration (eg. TQM / JIT)

Hard AMT justification process and protocols

Manufacturing paradigms:
- Pillars of excellence
- WCM
- IM
- Best Practice

Hard AMT’s. business environment and manufacturing strategy
Table 2.1 Advanced Manufacturing Technologies - Definitions

**HARD TECHNOLOGIES - Design Based Technologies**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Aided Design (CAD)</strong></td>
<td>The use of computers in interactive engineering drawing and storage of designs. Programs complete the layout, geometric transformations, rotations, magnifications and interval (cross section) views of a part and its relationship with other parts (C).</td>
</tr>
<tr>
<td><strong>Computer Aided Engineering (CAE)</strong></td>
<td>Allows the engineer to examine and test a design from a structural and Engineering viewpoint (D).</td>
</tr>
<tr>
<td><strong>Computer Aided Process Planning (CAPP)</strong></td>
<td>Produces both variant and generative process plans for parts, tools, jigs, and fixtures based on the group technology codes. This subsystem automates the process planning task as much as possible and reduces engineering lead times and ensures the quality of resulting plans. It also supports the use of similar manufacturing operations for similar parts, in accordance with the goals of group technology. CAPP supplies the same routing information as a conventional manufacturing engineering module provides (B).</td>
</tr>
</tbody>
</table>
Table 2.1 Advanced Manufacturing Technologies - Definitions (cont)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Aided Manufacturing (CAM)</td>
<td>The use of computers to program, direct, and control production equipment in the fabrication of manufactured items (C).</td>
</tr>
<tr>
<td>Computer Numerical Control Machines (CNC)</td>
<td>Large machine tools programmed to produce small-to-medium sized batches of intricate parts. Each CNC machine is separately controlled by its own microcomputer (A).</td>
</tr>
<tr>
<td>Direct Numerical Controlled Machines (DNC)</td>
<td>Multiple machine tools controlled by a central computer (D).</td>
</tr>
<tr>
<td>Bar Codes</td>
<td>A pattern of wide and narrow black bands and alternating white spaces that can be made by a computer using an optical scanner or wand. Can be used to record and convey product information (A).</td>
</tr>
<tr>
<td>Flexible Manufacturing Systems (FMS)</td>
<td>A configuration of computer-controlled, semi-independent work stations where materials are automatically handled and machine loaded (A).</td>
</tr>
<tr>
<td>Automated Material Handling Systems</td>
<td>Permits automated storage, retrieval, and movement of materials and component parts from storage to various work stations, finished goods inventory storage locations and shipping docks (C).</td>
</tr>
<tr>
<td>Robotics</td>
<td>Programmable machines designed to handle materials or tools in the performance of a variety of tasks (C).</td>
</tr>
</tbody>
</table>
### Table 2.1 Advanced Manufacturing Technologies - Definitions (cont)

**HARD TECHNOLOGIES - Administrative Technologies**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronic Mail (EMail)</strong></td>
<td>Usually consists of a host mainframe hooked up to numerous microcomputers. Special communications software allows users to contact the central computer to leave or pickup messages (A).</td>
</tr>
<tr>
<td><strong>Electronic Data Interchange (EDI)</strong></td>
<td>The computer-to-computer exchange of routine business documents over telephone lines using a standard format between two or more companies. Special communications software translates documents into and out of a generic format (A).</td>
</tr>
<tr>
<td><strong>Manufacturing Resource Planning (MRP II)</strong></td>
<td>Interconnected software packages that may include forecasting, master scheduling, order entry, engineering data, production data, inventory control, resource requirements planning, product cost tracking, manufacturing activity, planning, plant monitoring and control, plant maintenance, purchasing, receiving and distribution (D).</td>
</tr>
<tr>
<td><strong>Computer Integrated Manufacturing (CIM)</strong></td>
<td>Represents the union of hardware, software, database management and communications to plan and control production activities from planning and design to manufacturing and distribution (E).</td>
</tr>
<tr>
<td><strong>Group Technology (GT)</strong></td>
<td>An engineering and manufacturing philosophy that identifies the sameness of parts, equipment, or processes. It provides for rapid retrieval of existing designs and anticipates a cellular-type layout of production equipment Manufacturing cells are often considered to be an integral element (C).</td>
</tr>
</tbody>
</table>
Table 2.1 Advanced Manufacturing Technologies - Definitions (cont)

**SOFT TECHNOLOGIES**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resource Management (HRM)</td>
<td>Policies, programs, practices and systems which improve organisational effectiveness and efficiency through developing a working environment that facilitates employee empowerment, commitment and cooperation.</td>
</tr>
<tr>
<td>Just In Time (JIT)</td>
<td>The purpose of JIT systems is to produce or deliver the right items in the quantities needed by subsequent production processes or customers at the time needed. The intent is to co-ordinate production flows to reduce the needs for inventories. JIT is a pull system.</td>
</tr>
<tr>
<td>Total Quality Management (TQM)</td>
<td>Involves a few central concepts such as doing things right the first time, striving for continuous improvement and devotion to understanding of customer needs. Associated practices include statistical process control (SPC), quality function deployment and Taguchi methods (F).</td>
</tr>
</tbody>
</table>

Sources:

A Krajews and Ritzman (1992)
B Greene (1987)
C Fogarty, Hoffman and Stonebraker (1989)
D Meredith (1987B)
E Evans, Anderson, Sweeney and Williams (1990)
F Dean and Snell (1991)
Manufacturing and Best Practice have gained widespread acceptance as vehicles to improve manufacturing performance and competitiveness. The relationship of these transformational paradigms to Advanced Manufacturing Technologies constitutes a further area of research. The widespread inability of firms to realise the intended benefits of AMT has prompted many researchers, to measure organisational improvements and identify factors and attributes that support and impede success. In particular, hard AMT’s typically involve large fixed investments which cannot be readily written off, or disposed of, should results not live up to expectations. Consequently, researchers have devoted considerable time to the challenge developing suitable methods for evaluating proposed investments in hard AMT. This attribute is not mainstream to this dissertation and will only be briefly discussed.

2.5 Early Research - Hard AMT

Many early studies focused on automation without incorporating the effects of computerisation, which had yet to occur. Bright (1958), developed a scale dealing with *levels of mechanisation*. Mechanisation was characterised along seventeen levels range from Level I - ‘Hand’ to Level 17 - ‘Anticipating Required Performance and Adjusting Accordingly’. Bright also discussed a mechanisation profile which could be used to classify individual tasks or jobs within a system according to their level of mechanisation. In general, more mechanised systems tend to have more tasks at higher levels. A similar scale was developed by Amber and Amber (1962), whose *order of automaticity* defined ten sequential orders (or levels) through which automation proceeds, ranging from non-self acting (AO) to superhuman level capabilities (A9). The theme common to studies prior to the advent of microprocessor based machinery is that of the physical linkage of machinery to form a highly automated, relatively inflexible manufacturing system such as that typified by automobile assembly lines. These studies reflected the early emphasis of automation on *economies of scale*. In contrast, modern computer based automation such as computer aided design and manufacturing incorporates the potential for *economies of scope*. The contrast between economies of scale and scope is a key concept underlying AMT’s and their changing patterns of use, and is examined in more depth in the following section.

2.6 Economies of Scale Versus Economies of Scope

Traditional manufacturing technologies rely primarily on the concept of *economies of scale* in seeking improvements in production efficiency. The essence of economics of scale is that fixed costs can be spread out over large volumes of production, thus reducing the per unit cost. For example, if the fixed cost of operating a warehouse is one million dollars per year, then doubling the number of units processed through that warehouse from five million per year to 10 million per year results in a halving of the fixed costs *per unit* from $0.20 to $0.10.
Another aspect of economies of scale involves the sharing of changeover costs, whereby longer production runs for each given product result in a decrease in the total time spent setting up for production. A third advantage is the ability to take advantage of learning curve effects. Since traditional learning curve models assume that there is a proportionate reduction in the time to make a product every time production is doubled (i.e. the 2000th unit takes 80% as much time as the 1000th and the 4000th unit takes 80% as much time as the 2000th), the large volume production typical of economies of scale allows production to move down the learning curve at a greater speed. Finally, economies of scale allow manufacturing to remain focused on one, or at most, a few products, thus allowing the benefits of a focused facility to be achieved (Skinner, 1974).

One of the most widely used conceptual models of the relationship between economies of scale and traditional manufacturing technologies is the product-process matrix developed by Hayes and Wheelwright (1984). This matrix matches the life cycle stage of the product with the life cycle stage of the corresponding production process. Four general process life cycle stages are described: (I) jumbled flow (job shop), (II) disconnected line flow (batch), (III) connected line flow (assembly line) and (IV) continuous flow. Four matching product life cycle stages are described, ranging from (I) low volume, low standardisation, one of a kind type products to (IV) high volume, high standardisation, commodity type products. Product and process life cycle stages are combined on a single matrix in order to find the best match between product and process, as depicted in Figure 2.2.

The product-process matrix shown in Figure 2.2 indicates that products with low volume, low standardisation and which tend to be one of a kind are best produced using a jumbled flow or job shop type process. In this case, the wide variety of products and the small lot sizes require a production process which is flexible both in terms of workers and equipment. A commercial printer is demonstrative of a company which produces many different types of relatively small orders (as opposed to a newspaper publisher which only has a single product) and is best served by a job shop type process. In contrast, in situations where there is greater standardisation of products and higher volumes, the most effective process is that of a continuous flow where a single production line is dedicated to a product. This match between product and process is represented in the bottom right hand corner of the product-process matrix by a sugar refinery. In this case, the product is a commodity which is produced in high volumes with the associated process being a continuous flow which results in low unit costs due to the use of specialised equipment. The drawbacks of a continuous flow process include high fixed costs and low manufacturing flexibility, but for situations where product volume is high the fixed costs are spread over a large number of units and the existence of only a few standardised products obviates the need for flexibility.
Figure 2.2 The Product-Process Matrix

Product Structure, Product life cycle stage

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low volume-low standardisation, one of a kind</td>
<td>Multiple products, low volume</td>
<td>Few major products, higher volume</td>
<td>High volume-high standardisation, commodity products</td>
</tr>
</tbody>
</table>

I: Jumbled flow (job shop)

II: Disconnected line flow (batch)

III: Connected line flow (assembly line)

IV: Continuous flow

Source: Hayes and Wheelwright (1984)
The fundamental concept underlying the product-process matrix is that of economies of scale. Products toward the right hand side of the product-process matrix are relatively standardised, have high volumes and can thus take advantage of economies of scale to reduce the per unit cost. Products toward the left side of the matrix are not standardised and are produced in relatively low volumes and thus do not benefit from economies of scale. As demonstrated in Figure 2.1, the best match between product and process requirements is generally exhibited by firms which position themselves along the diagonal running from the upper left corner to the lower right corner. Firms occupying positions toward the bottom right of the matrix exhibit increasing economies of scale at the expense of decreasing flexibility. Although it is possible, and can even be beneficial, for firms to be positioned off the diagonal, the majority of firms occupy positions on or near the diagonal.

The product-process matrix described has been widely used to conceptualise the matching of products with manufacturing process. As noted by Challs and Samson (1995b), much of the analytical and empirical work that has been derived from this matrix is in the area of discrete parts manufacturing with particular emphasis given to the automotive and electronics industries. One key exception is the work of Ward and Miller (1991), who empirically validated the matrix. Their work compares the characterisations of the predominant production process for 124 industries (3 digit SIC code) as determined by an expert panel, with assignments based on objective variables using discriminant analysis. The results indicate that the model developed using objective variables predominantly agrees with the experts and that the vast majority of industries are positioned on the diagonal of the product-process matrix. In their suggestions for further research, Ward and Miller (1991), propose that a similar model could be developed to evaluate the effects of hard AMTs on the product-process matrix. They argue that for traditional manufacturing technologies, the product-process matrix provides a means of matching particular products with the appropriate manufacturing process, but the advent of hard AMTs allows firms to position themselves off the main diagonal of the product-process matrix.

Goldhar and Jelinek (1983), also support this view and developed the term economy of scope and contrasted it’s characteristics to economy of scale to illustrate their argument. In contrast to traditional manufacturing technologies which tend to focus on economies of scale for improving efficiency, Goldhar and Jelinek argue that hard AMTs derive many of their benefits from what have been termed economies of scope. Goldhar and Jelinek define economies of scope as "efficiencies wrought by variety, not volume". Goldhar and Jelinek, related how the characteristics of hard AMTs - extreme flexibility, rapid response to changes in demand and product design, greater control and repeatability of processes, reduced waste, faster throughput, and distributed processing capability support economies of scope. When a single process can be used for two or more products, economies of scope are realised through the spreading of fixed costs for the machinery over several different products. Firms that focus
on economics of scope tend to use general purpose equipment which provides greater manufacturing flexibility for more customised products. Much of the early research on hard AMTs concentrated on the ability to pursue economies of scope and the potential benefits of these new technologies.

In labelling CAM as a "contagious technology", Gold (1982) eloquently notes that new technology offers great potential benefit but poses severe organisational difficulties. In order to realise the value of CAM, Gold claims that managers must provide a new kind of technical expertise, organisational form and evaluation procedure. The need for a new management paradigm is repeated and amplified by Jelinek and Goldhar (1984) who analysed the linkages between design and operating characteristics in computer-based factories and technology strategies for competing in changing world markets. Zuboff (1982) also examines the necessity for both a change in the organisational arrangements and the empowerment of workers to accompany hard AMT implementation. These themes of economies of scope, changes to organisational arrangements, empowering employees and the incorporation of manufacturing in a strategic business context are constants in the hard AMT literature and are examined in more detail in sections that follow.

2.7 Hard AMT’s, Organisations and Human Resources

One of the prevailing themes found in the literature on hard AMT’s is that their successful implementation requires accompanying adjustments to the organisation and investments in human resources. Organisational adjustments include structural change, the redesign of work and the development of teams (Gold, 1982, Golhar and Jelinek, 1985, Wall, Corbett, Martin, Clegg and Jackson, 1990). Human resource investments include training, skills development and changes to role behaviours (Walton, 1985, Schuler and Jackson, 1987, Samson, 1991, ACBP, 1994). The basic premise is that computer based technologies offer a greater degree of flexibility (economies of scope) than do traditional technologies (which concentrate on economies of scale) and that the organisation must be properly adapted and its employees given appropriate skills and responsibilities to reap the full potential of hard AMT’s. In particular, researchers have argued that rigid, bureaucratic organisations which have historically been associated with highly automated, but non-computerised manufacturing systems such as assembly lines are not appropriate for more flexible hard AMT’s. Organisations that are appropriate for flexible, computer-based technologies have been characterised as organic, flat in structure, team oriented and in possession of a skilled, committed and empowered workforce. These observations clearly have significant implications for organisational structures and systems, the organisation of work and the roles of employees.
2.7.1 Hard AMT’s and Organisations

Among the first authors to recognise the importance of accompanying changes to organisational arrangements with hard AMT investments were Gold (1982), Gerwin (1982), Zuboff (1982), Goldhar and Jelinek (1983), Jelinek and Goldhar (1984), and Goldhar and Jelinek (1985). The need for a new kind of organisational structure is explicitly noted by Gold (1982) who observes that the multiple levels of authority involved with hierarchical organisations often represent a stumbling block to the effective implementation of hard AMT’s. The implication is that streamlining the organisation with fewer levels of authority engenders a greater ability to integrate hard AMT’s.

While the approach of most researchers is to focus first on the technical aspects of hard AMT’s and secondarily on the more human (managerial) aspects, Shoshana Zuboff (1982) takes a different tack in examining this issue. Zuboff uses her training in organisational behaviour to examine the social and managerial implications of new technologies. She notes that "information technology - offers managers a chance to develop new approaches to work organisation" (p. 142). Two alternative strategies to matching organisational arrangements with hard AMT’s form the focus of Zuboff’s (1988) book. As an organisation incorporates computers in its work environment, it can follow either an automating or an informing strategy. As defined by Zuboff, these strategies are not opposites, but are hierarchically integrated. Automation is a necessary, but not sufficient, condition for informing. In order to provide an understanding of the differences between the two strategies, the following definitions are paraphrased from Zuboff’s work:

An automating strategy occurs when computers and technology are used to perform operations in a manner that replaces the human body with technology, allowing the same processes to be carried out with greater continuity and control. When automation is the exclusive goal of computerisation, it essentially replicates the structure and objectives of scientific management or Taylorism. An automating strategy preserves and deepens the division between management and labor.

An informing strategy introduces another dimension into the workplace. Computers not only impose information (in terms of programmed instructions), but also generate information by tracking system activities. When used properly, this power of computers informs, or provides new information to workers throughout the organisation. An informing strategy undermines Taylorism, as the division between management and labour is blurred and responsibility is added to workers jobs.

These strategies clearly represent extreme states along a continuum. Although, both strategies involve a greater degree of intellectual effort than prior activities, there are
significant differences in terms of their objectives, assumptions and the nature of the associated organisational processes. Automation seeks to preserve the status quo and retain managerial control over knowledge, which Zuboff equates with power. In contrast, informing focuses on learning as a continuous process, seeking to add value through learning. Informating breaks down barriers throughout the organisation and facilitates the sharing of knowledge.

Wall, Corbett, Martin, Clegg and Jackson (1990), note that two different and contrasting forms of work design have been observed in connection with hard AMT. They note that many different researchers have addressed the issue of work design at a theoretical level, principally through sociotechnical systems perspectives, but only few have considered practical evaluations, and to their knowledge, no research has been performed that evaluates the relationship of work design to hard AMT system performance. Wall, Corbett, Martin, Clegg and Jackson (1990), define these two forms of work design as specialist control and operator control. A specialist control design philosophy minimises operator involvement, typically restricting operator duties to loading, monitoring and unloading machines and alerting specialists of a malfunction. Consequently specialist control deskills operator's work and reinforces the traditional division of labour. It clearly has parallels to Zuboff's automating strategy.

An operator control design philosophy maximises operator involvement and empowerment with operator tasks typically including equipment monitoring, maintenance, fault diagnosis and repair, work planning, scheduling and co-ordination, and process and plant improvement. Operator control designs apply teams of multi-skilled operators to maintain local control with specialists only involved when problems of a more complex nature are encountered. An operator control philosophy blurs the division of responsibility and enhances operator's work and has parallels to Zuboff's informing strategy. Wall, Corbett, Martin, Clegg and Jackson (1990), studied the degree to which work design philosophy (specialist control or operator control) impacts on the performance of CNC machines used for the assembly of circuit boards. The sample frame consisted of seven workstations in a single UK electronics firm. The performance of workstations was assessed before, immediately after and 70 days after new job designs were introduced. Performance was assessed by measuring equipment reliability and uptime. Wall, Corbett, Martin, Clegg and Jackson found the difference in performance between work groups designed around specialist control and operator control to be statistically significant with operator control groups demonstrating consistently higher performance levels. Consequently and with due regard to the limitations of a small and narrow sample frame, their findings lend some support for adopting an informing strategy when introducing hard AMT's.

Meredith, Hyer, Gerwin, Rosenthal and Wemmerlov (1986), describe several aspects of the relationship between hard AMT's and organisational arrangements. They note that there
is a need for research that examines changes in organisational arrangements along a number of dimensions over periods of time and that therefore can be used to quantify the extent of change. Specific areas of focus highlighted in their work include the nature of jobs under automation, the new role of managers and the need for new skills on the part of workers. In noting research needs, they also point out that much of the research in the area is relatively exploratory and that therefore "standard closed-response surveys have limited value" (p. 214). This observation is particularly germane to the current study. The status of hard AMT research has improved in the decade years since Meredith et al. (1986), wrote their prescription of research needs and research in this field has concentrated on exploratory case studies and the development of conceptual frameworks. This research has laid a strong foundation of theory regarding hard AMT's. One key objective of this dissertation is to test a number of these theories in a more broad-based manner using a large closed-response survey.

Two examples of the use of case based research to build a theoretical foundation are the work of Meredith (1987C, D). In describing the "15% control syndrome", Meredith (1987D), reports the results of interviews with 22 workers and managers. A regression of the number of direct reports (employees under a manager's supervision) against the degree of perceived control of quality and productivity indicates that as the number of direct reports increases, the manager's perceived ability to control productivity and quality decreases substantially. Meredith cites this as evidence in support of W. Edward Deming's rule that 85 percent of quality defects are due to the system within which a worker must function and only 15 percent of the defects are directly attributable to the worker. With respect to hard AMT, the implication of this finding is that by providing timely, accurate and relevant information, and facilitating information access, hard AMT compliments changes in organisational arrangements such as increasing the span of supervisory control, eliminating levels of supervision, devolving responsibility and forming work teams. Meredith asserts that firms must devote more attention to "strategic" rather than "tactical" control, and that "a cultural revolution may be necessary to achieve not just the requisite initial change to the organisational infrastructure, but even more difficult, the continuing changes required to the infrastructure" (p.111).

Another example of case-based research is provided by Meredith (1987C), who examines three FMS's operating at different stages in their life cycles. This insightful paper offers a portrait of the actual difficulties encountered and benefits achieved in the implementation of FMS's. All three firms experienced severe organisational problems as a result of the introduction of new technology. The individual cases aptly illustrate some of the organisational difficulties associated with hard AMT's and suggest that "the corporate-subsidiary form of organisation may not be ideal" (p. 60). Meredith calls FMS's "change instruments of gargantuan proportion" which force an organisation to rethink its entire operating system. The implication is that those firms which make significant accompanying investments in their organisational systems will succeed, while those that do not will fail. Hayes and
Jaikumar (1988) have also commented on the magnitude and scope of changes required in organisational arrangements when CIM is introduced. They liken the introduction of an FMS or CIM to be like "replacing an old car with a helicopter rather than replacing an old car with a new car." The change is one of kind and not degree. Hayes and Jaikumar indicate that significant changes in organisational structure, job roles and responsibilities, human resource policy, worker skills and knowledge and the development of learning processes are needed to provide the precision and science required to successfully implement and sustain CIM improvements.

One of the most influential papers in hard AMT research is the conceptual piece by Nemetz and Fry (1988), which focuses on the relationships between hard AMT's, strategy formulation and organisational design. Their model contrasts organisations applying flexible manufacturing technology (FMT, a form of hard AMT) to those with more traditional mass production technology. FMT organisations make use of economies of scope, have shorter product life cycles, greater integration and interdependence with both suppliers and customers, and have a more organic organisational form. In contrast, mass production organisations tend to operate in a stable environment, emphasise economies of scale, have a mechanistic structure and are very bureaucratic. Obviously the two types of organisational forms described represent the extremes of a continuum. Key questions raised in this article include the assessment of the position of firms along this continuum, the relationship of a firm's position to its performance and the impact of emerging manufacturing trends on firm's future position along the continuum. Nemetz and Fry (1988) conclude that the traditional (and highly successful) mechanistic organisational structure will become increasingly obsolete and more organic team based forms will become increasingly common but offer no empirical evidence to support their views. By relating the use of teams to aspects of employee and manufacturing performance, this dissertation makes a contribution in this area.

One of the most current and complete models of the relationship between hard AMT's and organisational arrangements is that postulated by Parthasarthy and Sethi (1992). Their conceptual model posits relationships between a firm's environment, manufacturing technology choices, business strategy, organisational structure and performance. Similar to Nemetz and Fry (1988), this model examines the relationships between these elements and provides propositions to guide future research. For example, Parthasarthy and Sethi (1992), suggest that when flexible automation is higher, the firm should place greater emphasis on linkages with suppliers, customers, and industry experts etc. in order to achieve higher performance. Additional propositions suggest that individuals should work in teams and that performance of a firm with a high degree of hard AMT usage will be greater if its employees possess a greater skill level. These propositions are conceptualised based on an extensive review of the literature and appear to make intuitive sense. Yet they remain relatively unsupported by empirical evidence in the literature.
As noted earlier, there is a dearth of empirical research on the relationships between hard AMT's and various organisational issues. The vast majority of existing research is case-study oriented however and consequently conclusions are unable to be generalised. An exception is the study of Jaikumar (1986), of 95 flexible manufacturing systems in the U.S. and Japan. In contrasting the use of FMS's in Japan and the U.S., Jaikumar developed some specific insights into the differences in organisational arrangements. For example, he writes of the Japanese systems:

"Not bound by outdated mass-production assumptions, they view the challenge of flexible manufacturing as automating a job shop, not simply making a transfer line flexible. The difference in results is enormous, but the vision that leads to it is human in scale. No magic here - just an intelligent process of thinking through what new technology means for how work should be organised" (p. 72).

Jaikumar goes on to describe some of the specific differences in organisational arrangements which contribute to greater success with FMS. In particular, he notes that flexible automation causes a shift from manufacturing to engineering, from just running operations to a more proactive role in planning them. Two additional observations include a greater emphasis on the rotation of engineers through a series of departments and jobs to broaden experience and skills, and the use of small teams of workers. Jaikumar's data indicates that both of these factors are important contributors to FMS success. Similar findings have been reported by Twigg, Voss and Winch (1992) in a study of 15 firms and the integrating technologies (e.g. job rotation, direct contact and teams) which they use.

2.7.2 Hard AMT's and Human Resources

Many authors have suggested that while the implementation of hard AMT's may reduce the demand for direct labour, it raises the required skill level of the remaining employees. For example, Adler (1986), examines the need for employees to master new skills and suggests that as automation takes over the tasks of employees at lower levels in the organisation, the average skill level of the organisation is raised. Adler notes that for every task transferred from worker to machine, a new task is created - that of reaping the advantages of the new technology. Three qualitative changes in skills are described: (1) new types of task responsibility, (2) a new degree of abstractness of tasks, and (3) new levels of task interdependence. The net effect is that of new demands on the skills of employees and a change in the structure of the organisation. Similar arguments have been developed by Jaikumar and Bohn (1986), Meredith, (1987A), Warnecke (1988) and Goldhar and Lei, (1994).

Other authors have suggested that not only does the introduction of hard AMT need to be accompanied with the development of employee skillsets but also with the recognition that firm performance is more dependent upon employee performance. As Warnecke (1988), argues, when hard AMT's are introduced "man grows in importance" and human input becomes
more of an intellectual than physical activity including the need for sophisticated maintenance, planning and process improvement. The implication of Warnecke's argument is that firms provide employees with training, skills and additional responsibility and make adjustments to their human resource processes (eg. selection, development and remuneration) to maximise the value of their people. Similar conclusions have been reached by many other researchers including Clegg and Corbert (1986), Majchrzak (1988) and Voss (1988). The general term we will use to describe the situation in which employees receive more training, responsibility and learn new skills is employee empowerment.

Zuboff (1988), asserts that the role of employees within the organisation is one of the primary differences between an automating and an informing strategy. To recap, automating seeks to preserve the status quo and retain managerial control over knowledge. In contrast, informing focuses on learning as a continuous process, seeking to add value through learning. Informing breaks down barriers throughout the organisation and shares knowledge freely. One of the primary components of an informing approach is worker empowerment. By providing workers with more responsibility, greater autonomy to make decisions, and more training to develop skills which can be used to tap the full potential of hard AMT's, Zuboff suggests that an informing approach is superior to automating. Another strong proponent of worker empowerment is Jaikumar (1986). He contends that new technologies force management into a new role, that of managing intellectual capital, not equipment. Once the hardware is in place, management's job is to nurture the intellectual capabilities of workers in order to create a competitive advantage.

The empowerment of workers is a consistent theme in the research of Meredith (1986A, B; 1987 A, C, E). For instance, a comparison of the experiences of large and small firms in implementing hard AMT's suggests that due to the "musical chairs syndrome" of shuffling and rotating managers, large firms have greater difficulties in training workers and exploiting their talents than do small firms (Meredith, 1987A). In another article, Meredith (1986B), emphasises the advantages of creating employee teams and rewarding employees for learning new skills. In summary, Meredith considers the firm's employees to be a critical resource and concludes that "technology may be the key to the future, but people are the key to technology" (Meredith, 1987C, p. 61).

The challenge of flexible automation is described by Adler (1986, 1988), as being posed by their higher knowledge intensity. He states that of all the implementation issues regarding hard AMT's, labor requirements are often the least well-managed. In fact, contrary to the belief of many managers that automating will result in deskilling, Adler finds that new technologies have the opposite effect of raising the overall skill level. This comparison of the old and new content of work under hard AMT's highlights differences in the amount and frequency of training, the responsibility and expertise of workers, and the need for interaction among workers. Hard AMT's are viewed as requiring a broad, ongoing investment in skills
rather than a narrow, one-off investment. Expertise is portrayed as requiring greater cognitive ability to solve problems with hard AMT's rather than experiential skill in performing rote tasks. Finally, Adler concludes that hard AMT's require a greater degree of interdependence, teamwork and interfunctional cooperation than the stand-alone nature of work with more traditional technologies.

A similar finding was obtained by Samson, Sohal and Ramsey (1993). They studied the experiences of Australian firms implementing hard and soft AMT's and found that human resource issues were central to success. In particular skills development, training, workforce involvement, delegation of responsibility, empowerment and acceptance of change were found to be critical success factors. The workforce strategies they found in successful firms were similar to those described as commitment strategies by Walton (1985). Walton defined two contrasting paradigms of management: management by control and management by commitment. He found major differences between the two paradigms in areas that include compensation policies, employee voice policies, labour management policies and employee assurances.

These works represent a small sample of the research which examines the issue of worker empowerment in relation to hard AMT's. Researchers have highlighted the need to provide more training, greater responsibility and new skills for employees to fully tap the potential benefits of new technologies. Most field work is case study based and is broadly concerned with describing the ways in which companies train employees and pursue empowerment strategies by allocating additional responsibility for defined tasks such as the planning and scheduling of work, the achievement of agreed performance goals, organising materials and balancing workloads. However, the adoption of empowerment strategies is based on human resource theories of competitive advantage which underpin the development of a "high performing" workforce. There is little quantitative research which examines the degree to which a "high performing" workforce relates to the achievement of world class manufacturing outcomes and evaluates which Human Resource Management practices and interventions, such as TQM, JIT and the adoption of workteams are important to energise and support a "high employee performance" work culture. By developing constructs and measures for a range of manufacturing improvement programs, technologies and practices, in addition to employee and manufacturing performance, applying these instruments to a large stratified sample of manufacturing firms and analysing the results, this dissertation makes a significant step toward closing this knowledge gap.

2.8 Hard AMT's, Business Environment and Manufacturing Strategy

The business environment in which a firm operates and the manufacturing strategy which a firm pursues are both important factors which affect the degree of success achieved when using hard AMT's. Both are subjects that appear often in the literature, but frequently are
not articulated in an explicit, clearly defined manner. Research in this area implies that hard AMT's are most appropriate in dynamic business environments in which flexibility is a key element of the firm's manufacturing strategy designed to meet the challenge of such a turbulent environment. Yet few studies have explicitly included either business environment or manufacturing strategy as a variable or a part of a conceptual model. This is particularly perplexing as a number of authors (Bolwijn and Kumpel, 1990, Stalk, 1990A, B, 1992, Blackburn, 1990, 1991, and Challis and Samson, 1995) have indicated that business environments will become increasingly dynamic and that quality and time will increasingly become key drivers of business performance. A key element of the strategy set to develop the organisational capabilities of responsiveness to order, flexibility of production and understanding of customer requirements is the full integration and utilisation of hard AMT's (Youssef, 1992).

The influential work of Nemetz and Fry (1988), offers one of the best treatments of this subject. Traditional mass production technology organisations are characterised as operating in a relatively stable environment with little change and a low degree of complexity. In contrast, flexible manufacturing technology (FMT) organisations are portrayed as conducting business in a more turbulent, dynamic and complex environment. The use of hard AMT's allows FMT organisations to take advantage of economies of scope in order to develop a manufacturing strategy well adapted to this environment. Instead of trying to control their environment and pursue a cost leadership strategy, FMT organisations use hard AMT's to adapt to their environment by emphasising product quality and a high degree of flexibility. Zairi (1993), also studied the relationship between hard AMT utilisation and business environment. He considered the application of a broad range of hard AMT's (CAD, CAE, FMS, AGV, CNC, IT) within 20 different UK manufacturing firms. The sample population used was representative of the sectors of plastics, engineering and automobile. Zairi's findings supported those of Nemetz and Fry (1988), but applied to a broader cross section of hard AMT's. He concluded that:

"on the whole, successful users of (hard) AMT compete on other criteria than price, such as quality, flexibility of response and the ability to innovate. This suggests that (hard) AMT is not purely adopted for economic reasons but to maintain the ability to compete in the longer term. (Hard) AMT is primarily adopted to gain flexibility to handle changes in products, to introduce complex designs and to respond to changes in demand at economical cost." (p28)

The notion that the combination of hard AMT's and the proper manufacturing strategy can help change the competitive environment is explored by Lei and Goldhar (1991). They argue that hard AMT's have effectively changed the barriers to entry in many industries. In the past, barriers included patents, large size and efficient plants, but the greater degree of flexibility offered by hard AMT's has the effect of lowering entry barriers and blurring the
boundaries between different industries. Lei and Goldhar (1988), suggest that companies "such as Canon, Eastman Kodak and Fuji-Xerox ... are using advanced CIM techniques and digital technologies to exploit sources of commonality between these once separate, disparate industries" (p. 9). In essence, the capabilities offered by hard AMT's allow firms to create a wider variety of products by focusing on economies of scope. This in turn creates the type of dynamic, turbulent environment which Nemetz and Fry claim that FMT organisations best operate within. This type of environment demands a new type of strategy, which Lei and Goldhar characterise as a combination of Porter's generic strategies (differentiation, cost leadership and focus). Lei and Goldhar term this new strategy "competing across multiple niches". In effect, the objective is to use the economies of scope offered by hard AMT's to deliberately fragment markets to the extent that competitors relying on low-cost and economies of scale can't compete in the new environment. A similar view is offered by Parthasarthy and Sethi (1992), who propose that flexible automation should be used proactively to alter the rules of competition in an industry, in effect creating an environment in which the firm has a competitive edge based on its use of hard AMT's.

The relationship between business environment, manufacturing strategy and hard AMT's is also studied by Williams and Novak (1990). This article explicitly examines the effect of business environment on the use of hard AMT's and the associated manufacturing strategy in three distinct types of markets. First, local monopoly markets are described as being relatively stable and shielded from natural competitive forces. As a result, firms in these markets do not emphasise economies of scale or scope in their strategies. Instead, profits are based on the ability to sustain high prices rather than from innovations in products and processes. These markets do not fit with the two archetypes contrasted by Nemetz and Fry (1988) and may not seem to be realistic, but several convincing examples are cited in support of this theory. Second, traditional commercial markets closely resemble the mass production technology organisation of Nemetz and Fry. Firms in these markets remain in a relatively stable environment but face a greater degree of competition. The emphasis here is on managing the evolution from product to process over the product life cycle (much as described by Abernathy and Utterback, 1975; or Hayes and Wheelwright, 1979B). The linkages in this type of environment are relatively tight, therefore limiting the degree of flexibility and focusing more on cost leadership. Finally, rapidly changing markets correspond roughly with Nemetz and Fry's FMT organisations. In these markets, the environment is turbulent and rapidly changing, with short product life cycles. Effective strategies therefore emphasise a greater degree of flexibility, a greater variety of products and more extreme learning curves with a greater investment in organisational and human resource development. An example offered by Kumpe and Bolwijn (1990), is illustrative: they state that Philips saw the number of compact disc models it offers jump from just 10 in 1982 to 150 in 1988. Williams and Novak also contrast IBM's hardware oriented approach with Philips' more people oriented approach to the
introduction and development of hard AMT's and pose the question: Which is better? They conclude that each approach has certain advantages in particular situations.

The need for a direct link between hard AMT usage and the firm's competitive strategy is examined by Schlie and Goldhar (1989). The central theme of this article is twofold: (1) hard AMT's greatly enlarge the scope of differentiation possibilities, and (2) hard AMT's also lower the cost penalty associated with differentiation. In other words, hard AMT's both enlarge the possible universe of product varieties as well as lower the cost of exploration within this universe. Schlie and Goldhar (1989), note that in order to achieve these benefits, a firm must concentrate not only on manufacturing, but also on manufacturing's relationships with other functional areas such as R & D, engineering and marketing. In terms of empirical research, there has been little work performed which examines these two subjects.

Meredith (1987A) presents detailed case studies of two small firms as an illustration of the potential strategic advantages which hard AMT's offer to small firms. The essence of his argument is that hard AMT's offer the types of benefits to which small firms are accustomed, and that small firms can therefore employ these technologies more effectively than large firms. Since large firms are often associated with a large degree of organisational inertia, which makes change difficult (Robbins, 1991), small firms can follow a strategy which focuses on reacting faster, both in the marketplace and within their own facilities. Put differently, Meredith (1987A), proposes that small firms are better positioned to compete in turbulent markets and can more easily position themselves as the FMT organisation described by Nemetz and Fry (1988). Peerless Saw company is cited as an example of a small company which followed a strategy emphasising flexibility to create a new market in which they held the competitive edge. Peerless' approach was to create specialised software which allowed them to customise their saw blades to suit individual customer orders (Meredith, 1985). In short, Peerless effectively created their own market niche and "now found themselves all alone in a high-margin, custom products market rather than the high-volume, low-margin, standard products market they were previously competing in" (Meredith, 1987A, p. 255).

Small companies however are not the only ones which have the ability to reap the benefits of hard AMT's. When faced with an increasingly dynamic and turbulent environment, Cummins Engine turned to a combination of group technology, CNC machines and FMS to attack its problems (Venkatesan, 1990). During the mid-1980's, Cummins was confronted with rising federal emission regulations on engines, intense foreign competition from companies such as Komatsu and Caterpillar, and increased customer demands in the form of responsiveness to order and responding to enquiries. The strategy Cummin's followed involved developing a system for classifying parts and determining if a part should be made on an FMS, CNC tool or in a dedicated manufacturing cell. There are two intriguing aspects of this article which are worthy of mention. First, Cummins discovered that FMS's can be used in different ways to achieve different types of flexibility. In Venkatesan's words:
‘... flexible machines may be important in ways Jaikumar has not specifically addressed: as a hedge against design changes, a push in the race to market, a means to service loyal customers. They are also a saving grace for dedicated machine cells, where part variations, though not really huge, are big enough to make changeover troublesome and where downtime costs more to Cummins than the flexible machine itself (p. 126).

The important point is not that Jaikumars’s (1986) observations regarding FMS’s are inaccurate, but rather, that it is absolutely critical to develop a manufacturing strategy to guide the proper use of hard AMT’s. This Cummins did effectively. The second key point of this article is that throughout the reorganisation at Cummins, relatively centralised, traditional organisational arrangements were retained. Cummins did not achieve the flatter, team based organisational structures prescribed by researchers such as Zuboff (1988), Adler (1988), and Nemetz and Fry (1988) and described in Section 2.7. This suggests the need for further research to assess the linkages between hard AMT, organisational arrangements and firm performance with a view to assessing “what works and why”.

The studies mentioned above focus on a few specific examples and are not generalizable due to their small sample size. Broader studies have been conducted by researchers such as DeMeyer and Ferdows (1985), Nemetz (1989), and Roth and Miller (1992). In examining data from manufacturing futures annual survey of firms in the U.S., Japan and Europe, DeMeyer and Ferdows (1985), study patterns of integration of information systems in the three regions. They observe that European respondents seem to follow a top-down strategy for achieving integration, while North American and Japanese manufacturers emphasise more of a bottom-up strategy. This research highlights some interesting relationships between hard AMT’s and manufacturing strategy, but does not include the effects of a firm's business environment or any linkages with the ultimate performance of the firm. Another study which uses data from the 1988 manufacturing futures survey is that of Roth and Miller (1992). This study includes a vital linkage with firm performance. They find that firms classified as Superstars (because they have achieved exemplar standards of performance) tend to use more hard AMT and follow a strategy of building a solid infrastructure of human support systems. In particular, Roth and Miller (1992), found that the greatest predictor of superstar performance was the adoption of strategies concerned with “total factor resource improvements”. The implication of this finding is that it is not the development of organisational, human resource and physical systems that differentiates superstar performance, but the ability of these firms to effectively combine and integrate these improvements and investments.

While the work of Nemetz and Fry (1988) has had a large impact, it is conceptual in nature and has not been tested in practice. Nemetz (1989) seeks to address this gap in her dissertation by examining flexible manufacturing technology and its relationship with strategy
and structure. The research results support the proposition that traditional theories regarding manufacturing strategy must be reformulated in light of the advent of computer based manufacturing technology. Much of the reported evidence supports the cumulative model of competitive priorities advanced by Ferdows and DeMeyer (1990) which holds that hard AMT’s allow manufacturers to simultaneously pursue multiple competitive priorities (cost, flexibility, quality and delivery). This theory is contrasted with Skinner's (1974) traditional trade-off theory which posits that a firm must emphasise a single priority and make trade-offs which result in superior performance in one area being offset by inferior performance in another. Nemetz’s dissertation provides support for the cumulative model of competitive priorities and represents a step forward, but there remain significant questions to be answered. Specifically, Nemetz poses the question “what integrating mechanisms work best for implementing advanced manufacturing technologies”? Aspects of this question are addressed in both the literature review and research proposition sections of this dissertation.

2.9 Total Quality Management (TQM)


In reviewing the TQM literature it is readily evident that there is no universally accepted definition for Total Quality Management. Despite the thousands of articles in the business and trade press, TQM remains a hazy and ambiguous concept (Dean and Bowen, 1994). To illustrate the breadth of definitions consider those offered by Ross (1993) and Snell and Dean (1992). Ross (1993), defines TQM as “an integrated management philosophy and set of practices that emphasis amongst other things, continuous improvement, meeting customer’s requirements, reducing rework, long range thinking, increased employee involvement and teamwork, process redesign, competitive benchmarking, team based problem solving, constant measurement of results and closer relationships with suppliers.” Snell and Dean (1992), define TQM as “..doing things right first time, striving for continuous improvement and fulfilling customer needs...”

This problem is at least in part due to the different definitions ascribed by various writers to quality. Juran, (1988), Garvin, (1988) and Sitkin, Sutcliffe, Schroeder (1994), have indicated that the word quality has many different meanings and interpretations. Akers (1991),
Donnelly (1991), Dumas (1989), Dimminie (1989) and Ebrahimpour (1986) state that consumer expectations are a major element of any quality definition. Kitchenham and Redmill (1990), Crosby (1985) and Bognossian (1988) define quality in connection with conformance with requirements. In contrast, Mayo (1986) defines quality in terms of its impact on performance. Mayo analyses the impact of quality on efficiency, attitude, cost control and customer satisfaction. Freund (1985), defines quality by taking a functional perspective. He cites the necessity to recognise certain key activities of product or process design, production and service operations and maintenance in connection with quality. Juran (1988), adopts a broader perspective and develops definitions for product features, customers, product satisfaction, conformance to requirements and product deficiency. Garvin (1988), discusses five approaches to defining quality and the generic terms, processes and philosophies used in connection with quality: (1) the transcendent approach and philosophy, (2) the product-based approach of economics, (3) the user-based approach of economics, marketing and operations management, (4) the manufacturing based approach and (5) the value-based approach of operations management. Garvin also develops an 8 dimensional framework to describe product quality. The 8 dimensions are: performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. There are similarities to Juran's quality definition although Garvin emphasises reliability, durability and serviceability.

The problem of TQM ambiguity is also compounded by the different emphasis of the various theoretical frameworks and prescriptions for success offered by various researchers. Leonard and Sasser (1982), claim that if an organisation is to be successful it should have top management's strategic support for quality, practice organisational-wide analysis to identify factors affecting quality, assign responsibility for quality to every major segment within the organisation, encourage open participation by employees in quality improvement, collect quality data, initiate reward and performance systems that are compatible with enhancing quality, develop a professional quality assurance staff, emphasise employee training and development and hire managers with a high concern for quality. Deming (1986), articulates 14 key principles for success which include strong management commitment, effective communication between supervisors and employees, the widespread application of statistical process control techniques and the elimination of numerical goals and quotas for employees. Juran proposes a number of principles that not only stress the technical aspects of quality management but that also include managerial perspectives such as quality planning, establishment of formal quality planning, quality audits and the development of a systems approach to the management of quality. Samson (1993), develops 8 principles associated with the implementation of a quality program. These include: people work in the system and managers must work on the system to improve it, the relevant definition of quality is that of the customer, improvement must be planned and continuous and better quality pays. Juran's (1988) framework involves three sets of activities: quality planning, control and improvement.

46
and emphasises the use of statistical tools to eliminate defects. Mondon (1982), identifies the key features of Toyota's quality system. These include: the integration of quality in all functions, effective use of quality professionals throughout the company, supplier participation in quality initiatives and active employee participation in quality circles. These authors and others including Bain (1982), Sashkin (1982) and Walton (1985) emphasise different sets of requirements for TQM based on their judgement, and experience in working with different organisations as consultants, researchers and/or managers. Consequently, these requirements for success have generally not been formulated on the basis of systematic empirical research.

Moreover, this limitation extends into research that seeks to evaluate the impact of TQM on organisational performance. Although most empirical studies do conclude that TQM does add some value, albeit debatable how much, most have been conducted by consulting firms with a vested interest in their outcomes and most do not conform with established standards of academic rigour (Powell, 1995). There is a general dearth of large, rigorous studies focusing on identification of the key elements of TQM and evaluation of their relationship to firm performance (Dow, Samson and Ford, 1996).

The International Quality Study (American Quality Foundation and Ernst and Young, 1991) studied the quality efforts of 500 automotive, computer, banking and health care organisations in the US, Canada, Germany and Japan. By a process of in-depth interviews, they found that some TQM practices, particularly supplier quality accreditation and process improvement, did universally improve performance but that the contribution of the remaining TQM practices varied dependent upon the firm's stage of advancement. Terziovski (1996), researched the impact of firm quality accreditation on firm performance within Australian and New Zealand manufacturing firms. He found that quality accreditation had no significant effect on firm performance unless accreditation was implemented within a "strong quality culture" characterised by employee empowerment, continuous improvement and customer focus.

Bacdayan and White (1993), studied a number of issues related to the adoption of quality practices. They found, amongst other things, a statistically significant and positive relationship to exist between employee participation and the successful implementation of quality initiatives. They also found the relationship between quality practices and firm performance to be positive and significant in work environments characterised by high levels of employee participation. Ramsay, Samson and Sohal (1991), surveyed 52 Australian manufacturing organisations to identify the nature of practices implemented, barriers to practice implementation and evaluate the impact of practices on performance. They found a measurable improvement in product quality, process quality and firm performance after TQM programs had been implemented. Powell (1995), surveyed and interviewed executives from 54 US manufacturing organisations. He found that practices generally associated with TQM (training, process improvement and benchmarking) did not produce improvements in performance but that certain tacit, behavioural and imperfectly imitable features such as open
culture, employee empowerment and executive commitment could produce improvement. Powell concluded that it is these features and not TQM tools and techniques, that drive TQM success and that organisations that can acquire them can outperform competitors with, or without, the TQM ideology. Redman (1995), analysed the responses of 880 organisations (actual survey responses) with the objectives of identifying the extent of adoption of TQM within the UK, the approaches and practices used, the techniques applied to measure and evaluate quality and TQM program outcomes, implementation issues and results achieved. He found over 70% of respondents had implemented a TQM program. Most respondents indicated that TQM had resulted in improvements in employee quality awareness (95%) and scrap and defect rates (59%) but only a relatively small number of firms (8%) reported improvements in business performance. Redman concluded that the lack of impact on economic measures of performance was making it increasingly difficult to justify and maintain the momentum of TQM.

Dow, Samson and Ford (1996), investigated the individual and combined effects of TQM on quality outcomes using a large stratified sample of Australian manufacturing sites (sample size of 1289 sites). They concluded that quality practices tend to occur in combination but that only employee commitment and customer focus appear to contribute to superior quality outcomes.

In summary, neither theoretical frameworks nor the results of empirical studies provide practitioners with a consistent set of principles or guidelines with which to guide TQM implementation effort. No doubt part of the problem is due to the different definitions, constructs and instruments used to define and measure quality outcomes and the various quality practices. Due to this ambiguity, TQM is in danger of becoming a type of Rorschach test, to which people's reactions vary as a function of their own beliefs and experiences.

Moreover, those studies that are concerned with the same practice (eg. customer focus, skills development or employee involvement) typically operationalise this practice using different sets of measures. The work of Saraph, Benson and Schroeder (1989), was an attempt to address this issue. They synthesised the work of 8 key authors in the field of TQM and identified what they believe to be the critical set of practices that constitute TQM. Eight key quality practices were identified and sets of operational measures that met accepted standards of academic rigour were developed for each. The eight practices were: the role of executive management and quality policy, role of the quality department, training, product/service design, supplier quality management, process management, quality data and reporting and employee relations. The author's indicated that although the initial results of their work were encouraging, much additional work needed to be done to corroborate their results and validate the reliability and validity of the measures and scales developed. Unfortunately, and for many differing reasons, none of the major empirical TQM research undertaken since this time (American Quality Foundation & Ernst and Young, 1991, Redman, 1995, Powell, 1995, Dow, Samson and Ford, 1996) has applied these scales.
2.10 Just-In-Time (JIT)

The origin of JIT is generally attributed to the work of Shigeo Shingo of the Toyota Motor Company in Japan in the late 1960’s. JIT has subsequently become a core concept of Japanese production management and productivity improvement, and has been introduced in many Western countries. Similar to TQM, many different definitions have been developed for JIT including:

- A way to visualise the physical operations of the company from raw material to customer delivery (Hall, 1983)
- A philosophy to achieve manufacturing excellence that improves the bottom line of the firm and increases Return On Investment, ROI (Schroeder, 1986)
- A philosophy that aims to minimise waste and eliminate all, non-value added activities, in all aspects of production processes (Taiby and Turnbull, 1987).
- The practice by which an operator passes along in-process inventory only when a signal is received from the next operator in the process (Musselwhite, 1987).
- A managerial philosophy and a decentralised shopfloor control system (Samson, 1991).

Schonberger (1986), Voss (1987); Wantuck (1987); Hopkins (1989); Gunn (1987) and Ciampa (1988), are among a long list of practitioners and academicians who have developed alternative definitions for JIT. One could, and some do, indulge in endless speculation concerning JIT definition. Oliver (1990), analysed a representative cross section of JIT definitions and commented:

“...much of the current debate on JIT is reminiscent of the three blind men trying to understand the nature of the elephant on the basis of a small part which each of them has touched. JIT is a many faceted animal and needs to be understood as such.”

In synthesising various author’s works, two common themes emerge. First, the core elements and characteristics of JIT appear to be: small batches, set up time reduction, cellular manufacturing, multiskilled workers, teams, quality at the source, preventative maintenance, Kanban/pull production scheduling and supplier arrangements. Second, and to varying degrees, the term JIT has some degree of overlap with other managerial philosophies such as TQM, Computer Integrated Manufacturing (CIM), Value Added Management (VAM) and World Class Manufacturing (WCM). In fact in many of the firms studied as part of this research project, JIT had been subsumed by other programs.

Maskell (1987), views JIT as a philosophy that involves organising the production process so that the minimal necessary levels of parts and subassemblies - both manufactured and purchased - are available on the shop floor just as they are needed. Maskell defines the core elements of a JIT strategy as:

- building a Customer/Vendor relationship with small but frequent delivery of materials,
- establishing long-term purchase orders with vendors,
- implementing TQM, which requires company wide education and commitment to quality,
implementing production planning that is accurate, timely and flexible,

reducing setup times.

O'Neal and Bertrand (1986), examine JIT from the perspective of the firm-supplier relationship. They indicate that a growing number of U.S. industries are implementing JIT, typically in conjunction with a TQM program. O'Neal and Bertrand (1986), also indicate that a number of JIT successes have been reported where TQM has not been implemented. They found that firms that have adopted JIT and TQM emphasise supplier evaluation and selection techniques which consider long-term financial strength, size, and technology. O'Neal and Bertrand (1986), also found a trend away from the traditional adversarial master - slave firm-supplier relationship toward one of partnering (Sheridan, 1990).

Schroeder (1986) operationalized a number of JIT concepts which are illustrated diagrammatically in Fig 2.3. According to Schroeder (1986), the genesis of JIT production activity commences with worker's and manager's suggestions and ideas for quality improvement, reduced setup time, and improved processing. Ideas for reducing set up times are considered in respect to their impact on production cells and the imperative to reduce lot sizes. Process changes are divided into two groups: changes related to technical systems and changes related to social systems. JIT outputs include increased revenue, reduced waste, and reduced investment stemming from lower inventory and staffing levels. The net result of these outputs is an increased return on investment (ROI). The outcomes of the JIT process are also feedback to workers and managers thereby fuelling a new cycle of the process.

Myers (1987), views JIT as a continuous improvement strategy. A strategy that is based on:

- mixed or continuous production.
- reduction of setup times.
- responsive procurement pipeline.
- quality-at-the-source.
- compression of shop space and flow lines, and
- people as problem solvers.

Myers (1987) also indicates that top management support is an essential ingredient for the successful adoption and implementation of JIT.

Musselwhite (1987), indicates that within the US, JIT frequently has a poor track record as many managers view, and treat it as a "quick fix" solution, addressing the procedural and skills issues without due regard for the necessary changes required in the attitudes of the workforce and pervading site culture. According to Musselwhite, in order for JIT to create a sustainable source of improvement, long term planning, ongoing executive management support and mechanisms to integrate JIT with other organisational initiatives and systems are...
Ideas for improving quality

Small-lot production

Stable master schedule

Kanban pull system

Companywide Q.C.

Increase of revenue

Ideas for reducing setup times

Ideas for changing the process (equipment, training, etc.)

Multifunction worker

Equipment and layout

Vendor participation

Just-in-time production

Cost reduction by eliminating waste

Return on investment increase

Less investment

Deliberate withdrawal of Kanbans

Reduce inventories and/or workers

Problem-solving activities by workers and management

required. Musselwhite defines the specific requirements for successful implementation of JIT as:

- Plant-wide quality control.
- Exposure and examination of every defect.
- Worker responsibility for repair.
- Production worker accountability for equipment maintenance.
- A production environment focusing on one product line.
- Group technology, and
- An order quantity of one order or one container.

Lubben (1988), argues that the term JIT conveys the idea that the three major components of manufacturing: capital, equipment and labor, are made available at the time required to perform the job and in the precise quantities required for the job. In a similar way to Samson (1991), Lubben describes JIT as consisting of two key elements: 1. A management philosophy that focuses on the integration, streamlining and simplification of the manufacturing system. 2. A set of operational practices devoted to the minimisation of elements in the manufacturing process that reduce productivity and consume time. This particular definition is interesting in that it has considerable parallels to the core TQM theme of Tribus (1988), that “managers work on the system to improve it: workers work in the system to improve it.” Lubben’s approach to applying JIT is illustrated in Figure 2.4.

Ansari and Batoul (1987), studied the potential benefits of JIT purchasing in U.S. manufacturing firms. They sampled a total of 54 firms and gathered information in a number of areas including relationship with vendors, methods of inbound freight transportation, receiving inspection procedures, benefits of JIT purchasing, and problems involved in the implementation of JIT. Results indicated that firms implementing JIT purchasing realised substantial economic benefits. Inventory turnover doubled, compliance with delivery schedules improved from 67% to 83%, scrap and rework decreased by 40%, and the lead time on delivery dropped from 77 days to 64 days.

In a detailed piece of work, Ramsay, Sohal and Samson (1990), studied 30 Australian manufacturing firms that had either implemented, or were in the process of implementing JIT. Their work addressed two key questions. What benefits had been obtained from JIT and what were the factors and issues that impacted on its success? Success was evaluated from the standpoint of program implementation, program and sustainability and the impact on manufacturing performance. Firms studied represented a broad cross-section of manufacturing industries including automobile, electronics, machinery and equipment, building products and textiles. Data was gathered using a set of semi-structured interviews with general managers, production managers, factory managers and other key personnel involved with the JIT process. Ramsay, Sohal and Samson (1990), found inventory reductions of 50%,
## Figure 2.4
An Overview of JIT Approach to Manufacturing

<table>
<thead>
<tr>
<th>Goals</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Design for optimum quality and ease of manufacturing.</td>
<td>Minimise the resources expended to produce a product.</td>
<td>Be responsive to the customer.</td>
<td>Develop trust and open relationships with both suppliers and customers.</td>
<td>Develop the commitment within each function and all employees to improve the total manufacturing system.</td>
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<tr>
<td><strong>Objectives</strong></td>
<td>1. Design for customer satisfaction.</td>
<td>1. Integrate and optimise every step in the manufacturing process.</td>
<td>1. Provide customer with the product he wants.</td>
<td>1. Gain supplier and customer confidence in the company’s ability to maintain commitments.</td>
<td>1. Do each job right every time.</td>
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<td></td>
<td>2. Reduce the costs of manufacturability.</td>
<td>2. Build product to specification.</td>
<td>2. Develop manufacturing flexibility.</td>
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<td>2. Use an open systems approach to planning implementing a JIT system.</td>
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<tr>
<td></td>
<td>3. Design products for manufacturability.</td>
<td>3. Set manufacturing standards at zero defects.</td>
<td>3. Use long-term contracts.</td>
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<td></td>
<td>4. Minimise design and production costs.</td>
<td>4. Have each function be responsible for its own quality.</td>
<td>4. Use long-term contracts.</td>
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<td></td>
<td>5. Design for product robustness.</td>
<td>5. Use work cells and pull production processes.</td>
<td>5. Use work cells and pull production processes.</td>
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<td></td>
<td><strong>Strategies</strong></td>
<td>6. Locate and remove sources of excess inventory.</td>
<td>6. Locate and remove sources of excess inventory.</td>
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<td></td>
<td>7. Set manufacturing standards at zero defects.</td>
<td>7. Set manufacturing standards at zero defects.</td>
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<td>8. Have each function be responsible for its own quality.</td>
<td>8. Have each function be responsible for its own quality.</td>
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<td></td>
<td>1. Reduce manufacturing lead time.</td>
<td>1. Design product to meet customer requirements.</td>
<td>1. Design product to meet customer requirements.</td>
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<td>2. Provide product on schedule.</td>
<td>2. Reduce manufacturing lead time.</td>
<td>2. Reduce manufacturing lead time.</td>
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<td>3. Provide product at the expected quality level.</td>
<td>3. Use open kimonos policy to develop supplier and customer confidence.</td>
<td>3. Use open kimonos policy to develop supplier and customer confidence.</td>
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<td><strong>Tactics</strong></td>
<td>4. Use long-term contracts.</td>
<td>4. Use long-term contracts.</td>
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<td></td>
<td>1. Stabilise the supplier base.</td>
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<td>2. Fail-safe the production process.</td>
<td>2. Establish a company-wide defect prevention program.</td>
<td>2. Establish a company-wide defect prevention program.</td>
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<td></td>
<td>3. Use a kanban system for triggering production requirements.</td>
<td>3. Use total quality control and statistical process control techniques.</td>
<td>3. Use total quality control and statistical process control techniques.</td>
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<td>4. Eliminate all unnecessary inventory.</td>
<td>4. Set up a company-wide policy for doing the job right.</td>
<td>4. Set up a company-wide policy for doing the job right.</td>
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<td>5. Reduce or eliminate lead time from suppliers, overhead processes, manufacturing functions.</td>
<td>5. Deliver quality product on schedule.</td>
<td>5. Deliver quality product on schedule.</td>
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<td>6. Use flexible production processes and equipment.</td>
<td>6. Use flexible production processes and equipment.</td>
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<td>7. Train employees to operate a large variety of processes.</td>
<td>7. Train employees to operate a large variety of processes.</td>
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</table>
reductions in throughput times of 80% and lead time reductions of 60% to be typical. Many improvements occurred simultaneously and were found to be mutually reinforcing. Key factors that were critical to JIT success included sustained senior management support, thorough examination of company operations to ascertain the applicability of JIT, employee involvement and support, systematic analysis and the pre-existence of a quality program. These considerations will be further explored as part of this research.

At four of the thirty sites, Ramsay, Sohal and Samson found that the JIT program had failed and had subsequently been abandoned. In three of these four cases employee's cited a lack of managerial support as a key reason for program failure. Further analysis of these cases showed that JIT had stalled because the organisation did not have the necessary spare resources to assess and implement the recommendations made by employees and as a consequence the improvement process had become backlogged. Many of the recommendations made by employees required significant input from other work groups whose resources were already heavily committed in other "high priority" areas. Managers had also greatly underestimated the number of initial recommendations that would be made. Although, in all instances, manager's responded to this problem by commending workers for their "valuable contributions" and by reiterating their personal support for the program, many employees perceived these as "hollow words", became frustrated and withdrew their support. This finding is also supported by the work of Kaufman (1992). Based on his extensive experience as a manufacturing consultant, Kaufman (1992), identified contradictions between managerial intent and managerial action as one of the principal reasons why organisational improvement programs fail.

The work described in this section represents a cross section of JIT research activity. To the author's knowledge, to date, there have been no quantitative studies that use a large database (in excess of 1000 firms) and that are representative of all manufacturing sectors which: 1.) evaluate the extent to which JIT is associated with world class standards of employee and manufacturing performance and 2.) assess the impact of other practices and interventions, such as leadership, work teams and TQM on these relationships. This dissertation is directly concerned with these issues.

2.11 Organisational and Human Resource Development

To date we have considered the interest in the development of human resources and the associated organisational systems as a concomitant to the introduction of hard AMT's. However, during the last decade the competitive pressures of the global marketplace have diminished traditional sources of competitive advantage once held by larger firms in industrialised countries (Lawler, 1992, Porter, 1990, Reich, 1990, Thurow, 1992). Coupled with increased international competition is the growing preference for value added products and
services as well as customer demands for quality, flexibility and timely response (Peters, 1991, Reich, 1991). These pressures have elevated the interest in developing organisational practices and human resources in order to improve firm performance (Buchanan, 1989, Lawler, 1992, Osburn et al, 1990, Peters, 1991, Reich, 1987, 1991, Stalk, 1990, 1992, Tjosvold, 1986, Wellins, Byham and Wilson, 1991). This interest has also been fuelled by the emergence during the last decade, of a stream of research that posits that certain organisational and human resource attributes can form the basis for a firm's sustained competitive advantage in their own right (Barney, 1986, 1991, Stalk, 1992). This literature base has developed from two different perspectives. A behavioural psychology perspective termed the resource based view of competitive advantage and a business strategy perspective termed the capabilities based view of competitive advantage. The terms resources and capabilities are widely and interchangeably used and have been have been labelled distinctive competence (Fiol, 1991, Reed and DeFillipi, 1990, Selznick, 1957), core competence (Prahalad and Hamel, 1990), firm specific competencies (Pavitt, 1991) organisational capabilities (Stalk, Evans and Schulman, 1992, Ulrich and Lake, 1990) and organisational capital (Prescott and Visscher, 1980, Ranson, 1987, Tomer, 1987) reflecting a broad range of research objectives and theoretical perspectives.


Both the resource and capability view suggest that investments in organisational and human resource capital can contribute to the sustained competitive advantage of the firm through facilitating the development of competencies that are firm specific, produce complex social relationships, are bedded in a firm's history and culture and generate tacit organisational knowledge (Barney, 1992, Reed and DeFillipi, 1990, Wright and McMahon, 1990). In particular, many researchers have argued (Schuler and Jackson, 1987, Schuler and Walker, 1990, Sherwood, 1988) that human resource management practices can contribute to competitive
advantage in so far as they elicit and reinforce the set of role behaviours that result in lowering costs, enhancing product differentiation, or both. Although practitioners generally agree with this view a number of researchers have noted that practitioners seem to have considerable difficulty in putting it into practice (Samson, 1991, Schonberger, 1994). Further, not only does there appear to be difficulty in implementing human resource practices but there also appears to be a degree of reluctance by some firms to commence the reform process. Kinnie and Straughton (1991), studied the improvement programs and processes within 7 major manufacturing facilities, and concluded that although there was a broad recognition of the importance of human resource systems and policies in respect to the development of competitive weaponry, firms were reluctant to make investments in these areas. The Australian Centre for Best Practice (1994A), also noted this reluctance by firms to invest in their organisations and people through interventions and practices that include benchmarking, strategic planning, organisational restructuring, work redesign, training and skills formation, performance measurement systems, industrial relations reforms, the development of teams, occupational health and safety initiatives and various customer and supplier improvement initiatives. As a consequence, the Australian Manufacturing Council (1994B) include demonstration activity (eg. newsletters, conferences, site visits, networking etc) as a significant component of their Best Practice programs with a view to educating firms of the benefits from these investments and as a consequence, reduce this reluctance to invest.

Amongst researchers there also remains, a significant degree of difference in opinion as to precisely what type and form of human resource investments are appropriate to a given situation (Guest, 1987, Thomas, 1988, Hendry and Pettigrew, 1990). Boxall (1992) notes that many researchers have prescribed normative models of “best practice” in the area of HRM without providing a credible framework for the student and practitioner. With respect to specific investments in human capital a number of researchers have suggested that the human resource practices of selection (Dimmick and Murray, 1978, Zajack, 1990), training (Russell, Terborg and Powers, 1985), performance appraisal (Schuster, 1984) and reward systems (Balkin and Gomez-Mejia, 1987, Murphy, 1985, Zajack, 1990) may each bear some relationship to firm performance. Many HRM researchers support the need to develop and validate an appropriate set of test instruments with which to measure HR practices and assess their relationship to performance and other areas of firm investment. The principal area of work that has been performed in this area is that of Snell and Dean (1992), who examined the relationship between the three facets of integrated manufacturing : TQM, JIT and hard AMT and various HRM practices within three different functions, operations, production control and quality. Sample size was approximately 100 firms. Snell and Dean found a number of statistically significant relationships to exist supporting the general proposition that investments in integrated manufacturing are accompanied with investments in HRM practices.
Schuler and Jackson (1987), define 12 dimensions of employee behaviour which can be considered as 12 dimensions along which a firm should position its HRM strategy so as to ensure fit with its business and manufacturing strategy:

- the degree to which behaviour is repetitive/predictable vs creative/innovative
- time horizon: short term to long term
- the degree of interdependence: cooperative/team to independent/autonomous
- the degree of concern for quality
- the degree of concern for quantity and productivity
- degree of acceptance of risk taking
- degree of concern for process vs degree of concern for results
- preferences to avoid or to assume responsibility
- the degree of flexibility and tolerance for change
- the degree of comfort with stability versus ambiguity
- breadth of skills: specialist to multiskilled
- the involvement and commitment to the job and organisation

Schuler and Jackson (1987), argue that firms need to position their HRM strategies differently along these axioms dependent upon their strategic intent. For example, a firm pursuing a highly innovative strategy would seek a percentage of its employees with low concern for process whereas a firm seeking to compete through product quality would seek to develop employees with a high concern for producing and delivering goods and services.

Samson (1991), defines a number of key axioms which can be used as a roadmap to guide investments in HRM practices:

- formally articulated strategic organisational vision and policies of conduct
- the leadership capability to gain employee acceptance of the organisation’s core philosophy and change process
- organisational structure (arrangement of functions and resources)
- development of autonomous/semi-autonomous work teams
- work design (arrangement of the core work)
- employment policy including termination process
- job classification and payment systems and policies
- development of an egalitarian work environment
- open information sharing culture
- development of participative processes to engage the workforce
- processes and forums that facilitate the devolution of responsibility

These axioms are broadly in agreement with the work of Badawy (1993), Collins (1988), Merideth, (1989), Bowen and Lawler III (1992), Safizadeh (1991), Ulrich (1991), Australian Manufacturing Council, 1994B. A number of these axioms have been developed...
extensively in the literature (culture, work design, industrial reform). Three that are directly relevant to this dissertation are teams, leadership and strategic vision. These will be briefly discussed in the sections that follow.

2.11.1 Teams

The subject of work teams has attracted much recent attention in the management and behavioural science literatures and will be discussed here in some detail as many researchers have indicated that it is a key, if not the key, to substantial and sustainable organisational improvement (Lawler, 1992, Wellins, Byham and Wilson, 1991, ACBP, 1994). The writings of both researchers (eg. Cohen, 1991, Hackman, 1989, Lawler, 1992, Sundstrom, DeMeuse and Futrell, 1990, Adler and Cole, 1993), practitioners (eg Carr, 1992, Katzenbach and Smith, 1993, Wellins, Byham and Dixon, 1994) and the popular press (eg. Byrne, 1993, Denton, 1992, Dumaine, 1993) have reflected this interest. The enthusiasm for team based organisations has, in many respects elevated work teams to the status of panacea to the ills facing organisations. Work teams are commonly seen, for example as the answer to problems of employee alienation, poor quality and stagnant productivity (Lawler, 1992, Weisbord, 1987, Wellins, Byham and Wilson, 1991). Interest in team development has also been fuelled by increasing tensions associated with the conventional practices of organising and managing work. Historically, the division of time and labour, that is scientific management (Taylorism) has been at the root of traditional manufacturing job design effort. In some instances, this has had the effect of resulting in extreme specialisation with narrowly defined tasks with attendant poor employee morale, high absenteeism and high labour turnover. Consequently, many firms have invested in various processes to broaden employee work responsibilities including job enlargement, job enrichment and the development of team based work structures (Katz and Kahn, 1978). Consequently, high involvement strategies incorporating autonomous work teams are replacing the traditional hierarchies of power and control in organisations. Such strategies are said to give organisations the “ultimate advantage” by reducing costs, improving quality and flexibility and supporting innovation (Lawler, 1992). These supposed benefits have led to calls for a “management revolution” in which self managed teams become the basic building blocks of organisations (Peters, 1991) and a “corporate renaissance” (Kanter, 1983) using team based structures.

Work teams are believed to have a positive effect on productivity and quality (Lawler, 1992, Osburn, Moran, Musselwhite, Zenger and Perrin, 1990, Wellins, Byham and Wilson, 1991), the assumption being that work teams give employees a greater sense of ownership and pride in their work. Work teams are also said to give employees increased responsibility and decision making power (Lawler, 1992, Osburn, Moran, Musselwhite, Zenger and Perrin, 1990). These characteristics combined with greater job knowledge are thought to increase employees' commitment to continuous improvement in work processes and quality. It is also argued that
multiskilling team members improves the flexibility of the organisation, since skilled employees can rotate jobs and share workload (Lawler, 1992, Osburn, Moran, Musselwhite, Zenger and Perrin, 1990, Tjosvold, 1986). Work teams are also said to increase the level of communication and co-operation in the organisation (Lawler, 1992, Wellins, Byham and Wilson, 1991), leading to improved flexibility, faster response times and better problem solving. A more flexible organisation can respond faster to new technologies and products (Peters, 1991).

Despite the attention given to work teams there is a dearth of empirical knowledge in the literature that supports their contributions to organisational effectiveness (Goodman, Devadas and Hughson, 1988, Macy, 1993). Many authors (eg. Hackman, 1987, Osburn, Moren, Musselwhite, Zeger and Perrin, 1990) have made normative statements to the effect that the development of teams is related to superior performance but these relationships are yet to be empirically tested and proven. However, the relatively few studies that have been performed tend to lend some support for the proposition that work teams have a positive effect on organisational and employee outcomes (Katz and Kahn, 1978, Trist and Bamforth, 1951, Walton, 1972, 1982). However, some researchers have commented that these effects are more modest in studies that employ more rigorous designs (Cohen and Ledford, 1994). In a detailed case study, Hoerr (1989), studied the improvement efforts of a General Electric plant in the US. He reported that the introduction of teamwork based multiskilling had increased productivity by 250% and very substantial improvements had occurred. Hoerr (1989), found Japanese owned plants in Europe and North America had achieved high levels of productivity and work methods using local labour forces. Samson (1991), notes that analysis of the performance of these sites indicates that success can largely be attributed to the development of a team oriented work ethic. This finding is further supported by Adler (1993), who undertook detailed analysis and comparison of both the workforce management practices and performance of the Toyota-GM venture, NUMMI and Volvo's Uddevalla plant. Although many differences were observed in the human resource management practices between the plants, both were organised around production teams and these were viewed as a key ingredient in their success. Powell (1995), analysed the performance of 30 manufacturing firms and found that the construct 'open organisation', which combined the elements of empowered work teams, open communication and a relaxation of traditional performance was positively related to manufacturing performance. However Dow, Ford and Samson (1995), analysed the practices and performance of over 1000 manufacturing firms and found no statistically significant relationship to exist between the adoption of teams and quality performance.

Many of the contributions to the team literature over the last decade have been concerned with issues related to team adoption and the factors that impede and assist team development. For example, Adler (1988), indicates that the convergence of different manufacturing systems towards automated and flexible processes will result in increasing interest in the development of work teams. Susman and Chase (1985), present a social
technical systems analysis of the computer integrated factory and conclude that a compelling logic exists to organise workers into teams, a view supported by many other researchers (Osburn, Moren, Musselwhite, Zeger and Perrin, 1990, Macy, 1993, Hackman, 1989). Hoerr, (1989), defines three different types of work team (general purpose problem solving team, special purpose team and self managing groups) and describes the characteristics associated with each and the issues associated with their development and maintenance. Safizadeh (1991), discusses a number of issues related to work team effectiveness and concludes that managerial and supervisory attitudes, workers predilection toward individualism and team support protocols and processes are key barriers to effective team development.

Perhaps one of the more comprehensive works on work team development is that of Erwin (1995). Erwin studied the effectiveness of work teams in a large automotive manufacturing company taking into account the development stage or level of maturity of the work teams being studied. Using the 4 stage model of team development developed by Tuckman (1965), Erwin studied, amongst other things, the impact of team factors such as leadership, team cohesion, interpersonal conflict and role clarity on work team effectiveness for teams at the storming and norming stages of development. He found leadership, team cohesion and interpersonal conflict to be key attributes related to team development and performance. Erwin (1995) also indicated that a significant number of work teams would benefit from an accompanying set of HRM investments, at both an interpersonal and group level, in areas such as conflict resolution, building consensus, communication and giving and receiving feedback.

2.11.2 Leadership

Broadly speaking, in an organisational context, leadership translates into two key managerial competencies. First, the unique capabilities of the organisation's leaders and senior managers to articulate the vision, communicate the vision throughout the organisation and empower organisational members to realise that vision (Westley and Mintzberg, 1989). Consequently leaders need to both possess personal credibility and be able to obtain the trust of their employees to gain and maintain organisational support for the vision and the strategy set to achieve it. Second, the unique capabilities to enact a beneficial firm-environment relationship (Hambrick and Mason, 1984, Tushman and Romanelli, 1985). This implies that leaders are able to manage the complex set of relationships and interactions between various groups and key individuals representing the interests of shareholders, government agencies, customers, suppliers, strategic alliances etc. These managerial competencies, because they determine the acquisition, development and deployment of organisational resources, the conversion of these resources into valuable products and services and the delivery of value to organisational shareholders, can be potent sources of sustained competitive advantage (Castanias and Helfat, 1991, Lado, Boyd and Wright, 1992).
During the 1990's there have been a considerable number of studies undertaken that are concerned with the construct of leadership and its effect on organisational performance. Two key studies (Australian Manufacturing Council, 1994A, Powell, 1995) have evaluated various aspects of leadership and performance. The Australian Manufacturing Council, 1994A concluded that leadership was one of the most important differentiators between low and high performing manufacturing firms. Powell, found that leadership had a statistically significant effect on TQM performance. He did not, however, evaluate the effect of leadership on firm performance.

2.11.3 Articulating A Shared Vision

Strategy researchers argue that a firm with a well articulated strategic vision that embraces all aspects of its operations can potentially achieve sustained competitive advantage over those firms that lack such a vision (Hamel and Prahalad, 1989, Prahalad and Bettis, 1986, Prahalad and Hamel, 1990, Westley and Mintzberg, 1989). The strategic vision provides a cognitive map (Weick, 1979) that supplies the underlying logic for combining, deploying and mobilising resources within the firm and among the organisation's strategic business units (Prahalad and Bettis, 1986) and focuses and channels organisational competencies toward effective accomplishment of organisational goals (Westley and Mintzberg, 1989). Because strategic vision is inherently tacit, that is, it is not based on codified recipes for success, is specific to an organisation's unique historical context and is socially constructed through complex interactions amongst the organisations key actors, it may yield sustained competitive advantage.

Empirical research related to strategic intent is generally confined to research that examines the processes for strategy formulation and development. Unfortunately this research uses a wide range of strategic process models and different performance measures, resulting in little cumulative knowledge (Fredrickson, 1984, Guth and MacMillan, 1986, Wooldridge and Floyd, 1990). Furthermore, there is little convergence even among studies that use the same construct (Miller and Friesen, 1983, Fredrickson and Mitchell, 1984).

2.12 The Integration of AMTs

One of the greatest benefits and also one of the greatest challenges associated with AMT's is that of integration. By using the capabilities of computers to electronically link different machines and workstations together, theoretically, a single integrated system can be formed to control all of the activities of a given firm starting with raw materials and finishing with finished goods delivered to the customer. A decade ago, the ultimate goal was a "paperless factory" in which computers tracked all the information related to the production process and things such as paper bills of material, engineering drawings, product routings etc. would no longer be necessary. Unfortunately, the reality is that it is extremely difficult to
develop such a system and often these systems lead to less rather than more flexibility. One of the reasons behind this lack of success is the difficulties involved with the integration of different sub-systems.

Researchers have long held that integration offers greater benefits than the automation of individual processes. According to Jaikumar (1986), "only when separate 'islands of automation' in a plant start to link does management realise the possibilities for new kinds of competitive advantage via manufacturing" (p. 72). By tying together multiple systems, integrated AMT's offer the lure of greater control, but Jelinek and Goldhar (1984), caution that a firm must always remember the importance of flexibility in order to avoid developing a tightly coupled system which is too rigid. Consistent with our definitions of hard and soft AMT we define two broad types of integration: (1) hard - defined as the electronic or technical integration of computerised subsystems, and (2) soft - defined as the non-technical means of coordinating the efforts of different functions within the firm. Combinations of hard and soft integration clearly exist. An example of hard integration is the on-line exchange of product data between a CAM system and a CAD system. An example of soft integration is the coordination of activities between engineering and manufacturing in designing a new product to be manufactured through the team based workstructures and an associated set of work protocols.

2.12.1 Hard Integration

2.12.1.1 General

Meredith (1987B) examines hard AMT's in terms of three areas of application: engineering, manufacturing, and business planning, and notes that one of the major challenges facing firms is the integration of these three areas into a functional whole. The goal is to integrate these different functional areas so that they use a common database of shared information in the course of daily business. Meredith notes that there is often a certain chronological order in which integration occurs, with engineering systems being implemented and integrated earliest, followed by manufacturing and business planning systems.

Several researchers have developed taxonomies for the various integration types and describe their associated characteristics. Melnyk and Narasimhan (1992) describe two dimensions of integration. The first dimension concerns the application of integration, both its structure and its implementation. The second dimension is concerned with the types of integration. Four different types of integration are defined:

Functional Integration: Refers to the extent to which the functional area is integrated internally. In short, functional integration describes a manufacturing function that is internally integrated and in which all the major components are in 'synch'.
Organisational Integration: This type of integration deals with the links and coordination between the different functional areas of the firm.

Strategic Integration: Examines the extent to which the processes of formulating, implementing, and revising strategic objectives are coordinated with the activities of the functional area.

Channel Integration: Examines the linkages that exist external to the firm. Specifically, this type of integration examines two different directions that this type of integration can take. The first, forward interorganizational integration deals with the coordination of activities between the firm and its customers. In contrast, backward interorganizational integration ... focuses on the integration between the firm and its suppliers." (pp.76-77)

These types of integration are consistent with the those developed by Meredith (1987B), Schofield (1987), Snell and Dean (1991), Lei and Goldhar (1991), and Twigg, Voss and Vinch (1992).

Although their primary focus is on the justification of hard AMT's, Meredith and Hill (1987), also offer a useful framework of levels of integration. The lowest level is that of stand alone equipment such as machine tools or robots. Level 2 consists of cellular groupings of equipment such as Group Technology or FMS. The third level is that of linked islands. In this case, there are groups of machinery which are linked together electronically but there are still several distinct systems within a firm. Level 4 is defined as "Computer Integrated Manufacturing", where "full integration links the entire manufacturing function and all its interfaces through extensive information networks" (p. 57). Meredith and Hill summarise the characteristics associated with each level of integration and suggest that there is an orderly progression through the first three levels. In contrast, the move from the third to the fourth level of integration is not a simple one, and is more of a leap than a step. To further illustrate the concept of hard integration, these three examples CIM, FMS and GT are discussed in more detail in the sections that follow.

2.12.1.2 Computer Integrated Manufacturing (CIM)

There are numerous definitions of Computer Integrated Manufacturing. Evans, Anderson, Sweeney and Williams (1990), define CIM as "representing the union of hardware, software, database management and communication to plan and control production activities..."
from planning and design to manufacturing and distribution." Bonsack (1988), defines CIM as "a complex network of machines, computers, and people developing and producing products with greater efficiency." Warnecke (1988), defines CIM as "the information flow and technical integration of all operational areas involved in the product development process." Asghar (1991), defines CIM as "a vertical integration of computerised manufacturing system." Fogarty, Hoffman and Stonebraker (1989) define CIM as "an application of computer technology to take full advantage of both hardware and software development in conjunction with manufacturing technology and management practice." Meredith (1987), states that firms have achieved CIM status when "their design, planning, materials handling, manufacturing, and support systems (eg. order entry, cost accounting purchasing) are all linked together through computer. These different definitions reflect different combinations of research objectives and theoretical perspectives. For example, Asghar's (1991) definition reflects his research interest on evaluating the value of CIM as a conduit to link management and shopfloor activities and mindsets. Fogarty et al's (1989) definition reflects their theoretical emphasis on information technology and system concepts. Merideth's (1987) definition reflects the external focus of his work: how manufacturing interacts with other functions.

Meister (1987), states that CIM should not be defined in terms of products or services, but rather, as an environment in which companies can effectively implement solutions to critical business problems. Meister's work also distinguishes between automation and integration: automation representing a change in how a process is done with integration representing an opportunity to a change what is done. Consequently his definition of integration encompasses the strategic dimension of CIM that has been observed by many authors (Williams and Novak, 1990, Lei and Goldhar, 1991, Parthasarathy and Sethi, 1992) but is not explicitly mentioned in many definitions.

Many researchers have argued specific aspects of CIM. Wilder (1991), argues that CIM facilitates more stringent control of the process, and provides the manufacturing accountability necessary to meet increasing quality requirements. Ciampa (1988), argues that CIM creates a platform of integrated and automated systems that provides accurate and timely information to enhance the quality of decision making throughout the manufacturing process. Reed (1991), argues the value of CIM in respect to the pursuit of world class standards of performance. Feldman (1991), states that in addition to making large organisations more competitive, IBM's CIM Production Planning Series program addresses critical success factors such as the improvement and maintenance of quality. He also notes that the IBM program facilitates both horizontal and vertical communication of information as it incorporates requirements for electronic data interchange among the variety of programmable factory floor devices. Feldman (1991) also observes that this information technology platform not only facilitates more stringent control of the process but it also provides the managerial accountability necessary to meet emerging business requirements. Goldhar, Jelinek, and
FIGURE 2.5
Elements of CIM

Figure 2.6
CIM Framework as used by Arthur D. Little Inc.

FIGURE 2.7
Elements of CIM

Sales order processing
Design calculations
Computer aided design
Computer aided manufacture
Bill of materials

Contract specification

Spares department

Packing and dispatch
Quality assurance
Materials requirements planning
Purchase order control
Financial department

Common database

Figure 2.8
Elements of CIM

DNC
- Direct numerical control
  - Code generation

CAIT
- Computer-aided inspection and testing
  - Analog feedback
  - Quality feedback (defect rates)

CAM
- Computer-aided manufacturing
  - Group Technology codes
  - ECN grouping
  - Sourcing decision
  - Tooling & dies identified
  - Drawing/item number verification
  - Substitutes

Routing
- (And alternate routing)
  - Transfer machine instructions
  - Robot instructions
  - Process sheets

MRP
- Material Resource Planning
  - Capacity planning
  - Lot sizing
  - Inventory status
  - Lead times
  - Order release
  - Planned receipts
  - Manufacturing bills identified
    - Picking lists
    - Phantom BOMs
    - Pseudo BOMs
  - Configuration control

Management Controls
- Labor cost
- Material cost
- Overhead
- Variances
- Manpower schedules
- Cash requirements

Schlie (1991), described the overall benefits of CIM from the standpoint of competitive advantage. They argue that CIM makes it possible to create a factory and a product realisation system that has high levels of economy of scope as well as scale and therefore challenges the traditional volume, flexibility, variety and quality trade-off mindset.

A number of researchers have developed models to represent CIM and its key components. The degree of variation observed in these models is similar to that observed in CIM definition. Key works include Fogarty, Hoffman and Stonebraker (1989), Gunn, 1987, Slatter and Carven (1988) and Heizer (1986). These models are shown in Figures 2.5 through 2.8. Fogarty et al and Gunn's works exhibit a significant degree of similarity, each depicting CIM in respect to its key technologies and each using a seven item hard AMT representation. Slatter and Carven approach CIM from a hybrid functional and technological perspective with a common database in lieu of technology serving as the linch pin that joins the various elements. Heizer's CIM representation indicates a combination of technologies and activities and in addition indicates information flows between the various elements.

Many researchers discuss CIM benefits from differing points of view. Some have concentrated on the value of CIM from an information and information system perspective. Badiru (1990), argues that CIM provides the information necessary to manage and operate automated manufacturing systems. He proposes that information categories should be selected on the basis of their relevance to current requirements, the probability that they will be required for developing future system functionality and the degree to which they may contribute to the enhancement of that functionality. Nowak (1988), develops the concept of an Integrated Quality System (IQS) as a means of controlling the quality of information processed within a CIM system. He develops measures of CIM success that are based on the comprehensiveness of IQS functionality. Other authors have discussed the value of CIM in respect to its impact on manufacturing performance. Boudette (1990), and King and Freedman (1988), argue that CIM substantially reduces cycle time and lowers the minimum production level thereby increasing manufacturing flexibility. Powers (1988), argues that CIM improves process quality performance by improving quality control at each operational stage. King and Freedman (1988), Rohan (1987), and Badiru (1990) argue that substantial improvements in product quality is a key CIM benefit. According to Kahan (1991), a shop floor CIM system enables parameter tracking so that manufacturers can decrease the number of rejects and accurately analyse quality performance. Consequently he argues that CIM reduces time and cost, and improves quality.

2.12.1.3 Integrated AMT: Flexible Manufacturing Systems:

Much has been written about Flexible Manufacturing Systems (FMS’s). Components, implementation, justification, and advantages represent major areas of FMS literature. Chen and Adam (1991, P. 33) define FMS as "a computer-control configuration of semi-independent
work stations and material handling system designed to efficiently manufacture more than one part type at low to medium volumes." Ramchandam and Jaikumar (1986), developed a similar definition: "a computer-controlled grouping of semi independent work stations linked by automated material-handling system." Yau and Buzacott (1986), have developed another definition that emphasises FMS's integration perspective: "a combination of the existing technology of NC manufacturing, automated material handling, and computer hardware and software to create an integrated system for the automatic random processing of different parts across various work stations in the systems."

According to Chen and Adam (1991), the origin of FMS started in the mid to late 1960s as a logical growth of numerical control (NC) applications. Ouellette, Thomas, Mangold, and Cheremisinoff (1983), reported that by integrating NC and Computer Numerical Control (CNC) by a computer, manufacturers were provided with greater computational power, improved control and enhanced communication between the operator and the machine tools. This technology enables tools to be changed automatically, enabling many operations to be performed on the same piece by a single machine and adding considerable diversity to the manufacturing process. Further, machine centres can be linked, both physically (eg. automatically-guided carts) and electronically so that an item can travel from one machine centre to the next under the control of one or more control computers. Robotics can also be used to handle the parts and carry finished products and product changeover can be managed by software. Buffa (1985), reports the importance of applying this technology to U.S. industries. He indicates that 75% of machined parts in the U.S. are produced in a lots of 50 or less and argues that assembly-line techniques for which U.S. manufacturing has achieved international recognition are not applicable to the kind of batch production.

Rembold, Blume and Dillmann (1985), identified the potential benefits of FMS as:

1. Operating equipment around the clock: During the two day shifts, the equipment can be supplied with raw parts and properly maintained by personnel. Scheduling and supervision is done by the computer under operator observance. During the night shift (ghost shift) a computer supervises the operation independently and if necessary, turns the system off when problems arise.

2. Minimising direct labor: Machining, toll changing, fixturing, measuring, and material moving and handling are controlled automatically by the computer. Labor may be used during day shifts for observance functions, loading, unloading, and maintenance.

3. Minimising lead time: This is performed by the computer, which knows the production schedule and the machine status.

4. Reducing in-process inventory: Since a FMS operates on the flow line production principle, in-process inventory buffers are reduced to a
minimum. They may only be maintained to provide parts during a possible equipment failure.

5. Reducing tools and fixture requirements: Since FMS produce a larger part spectrum, universal tools and fixtures are used. This results in shorter retooling and setup times.

6. Obtaining high flexibility: The part spectrum for which a FMS is conceived has a major influence on the flexibility and utilisation of the equipment. Future product variants, engineering changes, and manufacturing methods should be anticipated when such a system is conceived.

Canada and Sullivan (1989), argue that FMS allows the continuous manufacture of different items within a family of parts in small batches within a dedicated machining facility. FMS can achieve low-volume but high variety and consequently allows additional models to be added to the company's product range at relatively minor cost. Weintraub (1988), considers that FMS has become a viable option in apparel production because the group system reduces conflicts in areas such as rates and quotes, good work and bad work, favouritism, and quality. Yost (1987) also indicated that FMS can be valuable to enhance quality if the product and process are designed together.

Empirically, Tombak and DeMeyer (1988), conclude that firms which implement an FMS are generally more concerned with issues of vendor quality and lead times than non-FMS firms. Nemetz and Fry (1988), demonstrate that FMS firms synthesise unit and batch production, mass production, and continuous process production, thus allowing them to exploit the advantages of each. Hill (1985), compares the advantages of FMS and conventional manually-operated machines and numerically controlled machine tools. He found that FMS installations are associated with decreased times, costs, and inventory: and increased utilisation, market share, profit, quality, and responsiveness.

Many other researchers have focused their efforts on issues related to the major components of FMS such as flexible machines or work stations; automated material handling system; and computerised networks, Key works include Fox (1987), Remold, Blume and Dillmann (1985), Tombak and De Meyer (1988), Lim (1987) and Sethi and Suresh (1990).

2.12.1.4 Group Technology

Group Technologies (GT’s) have been developed in response to increased emphasis on the concept of process-focused production (Meredith and Hill, 1987, Samson, 1991). According to this concept, all operations that have similar technical processes should be grouped together in order to form a specific production facility.
Canada and Sullivan (1989), define GT as "a method of classifying parts into families according to similar shapes, or common manufacturing process operations." A key element of GT is the assignment of codes to components which may then be combined to form specific product families. Rembold, Blume, and Dillmann (1985), explained the criteria for grouping parts. According to them grouping could be either by geometric similarity or fabrication method. Fry, Wilson, and Breen (1987), argued that GT is a manufacturing practice which harnesses manufacturing resources for small lot production in much the same way as is done for mass production. However, instead of producing identical parts, a family of similar parts with similar processes is manufactured.

Many researchers (Samson, 1991, Canada and Sullivan, 1989, Fry, Wilson, and Breen 1987, Rembold, Blume, and Dillmann (1985), Hyer and Wemmerlor, (1984) have identified various benefits and advantages of using GT. Their collective findings may be summarised as:

- improved routing, handling, and machine loading,
- reduced set up, and process time,
- reduced working process and number of scheduled operations,
- reduced cycle times from vendors to customers,
- reduced manual inventory,
- reduced design proliferation,
- improved plant layouts,
- allows sorting part families according to codes or attributes and features.

Rembold, Blume, and Dillmann (1985), also, and in considerable detail, explain the benefits of a well-conceived GT classification system. They categorise the main benefits of GT into groups with each group considering one specific issue such as: engineering, process planning and quality control. For example, for quality control, Rembold, Blume, and Dillmann indicate that GT reduces sampling and inspection times, improves utilisation of measuring instruments, reduces time to locate defects, and facilitates the introduction of quality inspection practices.

2.12.1.5 Measures of Integration

During the past decade, several researchers have attempted to develop measures of integration. Nemetz (1989), develops two measures of integration for her survey. The first consists of nine ranked items (arranged in order of increasing levels of integration) which the respondent checks as either used or not used. The second is a list of questions regarding whether a manufacturing plant uses certain hard AMT's such as CAD, CAE etc., and for each one which is used the respondent is asked to rate whether it is (1) not linked to any other
technologies, (2) linked to a few other technologies, or (3) linked to almost all other technologies. Nemetz states that these two measures have a high correlation, which suggests that they are relatively valid measures. Unfortunately these measures are still very rough and do not possess sufficient ability to capture full range of integration types. More comprehensive measures of integration are developed by Yoon and Susman (1992). They develop measures for: (1) the integration of support functions, (2) the integration of core functions, (3) the integration of support with core functions, (4) the sophistication of support functions integration, and (5) the sophistication of core functions integration. Each of these measures exhibits high inter-item reliability and the set as a whole provides a much broader measure of hard integration than that used by Nemetz, (1989), and in all probability, represent the best set of integration measures currently available.

2.13 Soft Integration

Soft integration encompasses two different perspectives. First, as discussed in section 2.7, the experiences of firms that have introduced hard AMT (eg. FMS, CNC) suggests that these investments need to be accompanied with an appropriate set of investments in soft AMT. Many of the problems associated with poor hard AMT performance are due to managerial or organisational, rather than technical issues (Schonberger, 1986, Hayes and Jaikumar, 1988, Samson, 1991). Assuming that most firms make these soft AMT investments, this implies that the integration of hard and soft AMT is an area in need of significant improvement. Second, many firms adopt and implement bundles of soft AMT (eg TQM and JIT, TQM and work restructuring, team formation and innovative remuneration systems) in tandem. Whilst there are many cases where the introduction of a specific soft technology has resulted in a significant improvement in performance, the technologies should be linked together in ways that are mutually reinforcing in order to achieve maximum benefit and to ensure that these benefits are sustainable (Australian Manufacturing Council, 1994A).

Researchers have long noted the need to integrate hard and soft AMT. For example, Jaikumar (1986) attributes the use of small production teams and the rotation of engineers through all manufacturing departments as one of the major reasons why Japanese manufacturers have achieved considerably more success with FMS installations than their U.S counterparts. Aspects of soft integration which Adler (1986), finds support AMT usage include the use of small teams and the relocation of workers to encourage contact and the open exchange of information. Duimeiring, Safayeni and Purdy (1993), and Saraph and Sebastian (1992), both echo the suggestion that relocating workers to encourage inter-action is an effective method of achieving soft integration. Many other types of soft integration have been described earlier in section 2.7. Other researchers have described types of soft integration which are aimed at improving coordination but do not directly involve AMTs. Meredith (1987D), notes that there is a need for closer communication and better cooperation between
employees. His suggestion involves the use of project management and more of a matrix form of organisational structure. Ettlie and Reifeis (1987), present a study of several companies' efforts to integrate design and manufacturing. They focus primarily on soft integration, and consider how the developments to the work environment such as the introduction of team structures, improved communication and changes to job roles and responsibilities support the introduction of CAD databases for engineering and tooling. In his book on hard AMTs, Ettlie (1988) examines new technologies in terms of two types of innovation: administrative and technological. These innovation types roughly correspond to hard and soft integration, and Ettlie's primary proposition is that they must be matched to achieve what he terms "synchronous innovation". This theory is similar to others found in the literature, including Jelinek and Goldhar (1984), Jaikumar (1986) and Meredith (1987B).

Jacobs and Clemson (1994) suggest that TQM provides an effective vehicle to integrate employee efforts and CIM. Jacobs and Clemson (1994) argue that by providing employees with the tools and techniques to measure and improve the process and recognising the value of employee contributions in the operation and development of the process, TQM facilitates the development of an empowered and knowledgeable workforce with a participative mindset. Jacobs and Clemson (1994) also indicate that in their experience, the appropriate combination of CIM and TQM can energise a culture of continuous improvement, shorten cycle times, improve customer focus and improve quality to a greater extent than do the individual elements. Consequently these author's argue that TQM can address CIM's cultural change problems and therefore contend that CIM should be introduced within a TQM operating context. These findings are supported by Zairi (1993) who studied the interactions between combinations of hard AMT and TQM in 20 UK manufacturing plants. The sample population consisted of a mix of plastics, automobile and electronics firms. He found that hard AMT (defined in his work as CAD, CAM, CAE, FMS, CNC, robotics and JIT) could provide firms with the "strategic determination" to be able to compete on flexibility, quality, responsiveness to order and cost. However, TQM helped to provide the "organisational discipline" to realise the new business opportunities created through hard AMT investment by assisting the organisation to develop the necessary operating values. These include waste elimination, time compression and fostering a climate of group problem solving and value adding activities. Zairi (1993) found evidence of a "systems approach" (high level of soft integration) where hard AMT is a prominent element in the firm's business strategy and has been deliberately introduced to enhance a key aspect of business performance. He also found little evidence of soft integration where hard AMT was introduced to improve internal considerations such as efficiency or communication.

In their study of the practices of Victorian firms implementing JIT, Ramsey, Sohal and Samson (1990), found that 16% of the total number of firms implementing JIT were making significant investments in hard AMT, principally in the area of CNC machines. Of these firms in
excess of 80% reported that JIT had significantly assisted them in gaining employee cooperation by enhancing communication and co-ordination and by raising employee morale. These researchers also found that in those cases where JIT implementation had preceded, rather than occurred in parallel, with the introduction of hard AMT, that there was a need to make adjustments to JIT in areas that included set up times, preventative maintenance, production scheduling and purchasing to ensure synergy and fit. Ramsey, Sohal and Samson (1990), found that those firms that recognised this requirement reported not only improved hard AMT performance but also improved JIT program performance and the existence of a stronger relationship between JIT and competitiveness.

Various researchers have also considered the interdependency and interactions between JIT and TQM. One of the more notable works is that of Schonberger (1986). He argues that the two technologies are mutually reinforcing in many respects. For example, by assuring consistency of quality through TQM, there is no longer a requirement to protect against quality variability and therefore buffer stocks may be reduced. By reducing order processing times and improving customer response times JIT improves customer satisfaction, a key objective of TQM.

Ramsey, Sohal and Samson (1990) and Ramsey, Samson and Sohal (1991) also studied the interactions between JIT and TQM. They concluded that the adoption of various practices based on the principles of employee commitment and involvement to achieve changes in mindsets and organisational cultures underpins the use of these technologies as a basis for improvement. Ramsey, Sohal and Samson (1990) also found that JIT was more effective when implemented within a quality environment that when it was implemented in isolation. Where an organisation had developed an effective TQM operating environment, characterised by acceptance of change, management and employee co-operation, continuous education, problem solving and teamwork JIT was not only substantially easier to implement but achieved superior results.

Schonberger (1994) also notes that to be fully successful, TQM requires extensive changes in Human Resource Management, in particular work roles and responsibilities, performance management including rewards and decision making processes. He notes that if these initiatives are not effectively integrated false starts and “backsliding” (non-sustainability) are inevitable. Samson (1991), notes some characteristics of soft technologies may result in inconsistencies, both real and perceived. In particular, he notes that the discipline, precision and control required with JIT and TQM tools and techniques can result in limited workgroup and individual employee autonomy. For example, the closer firms strive for zero inventory the more the employee must pace his or her work to assure process flow. Statistical process control systems can similarly result in a high level of “work regimentation”. Consequently some TQM and JIT tools and techniques can foster the development of work environments that can lead workers to believe that they are working under a “control” rather than a “commitment”
paradigm. In this type of work environment, the introduction of human resource management practices that foster empowerment and decision making autonomy can easily result in cynicism and reduced management credibility. Samson (1991), notes that in a number of plants tradeoffs have been developed. For example minimum levels of inventory have been established to provide a reasonable quality of working life without significant adverse impact on quality, quality or other human resource management initiatives. The key implication of Samson's observations is that the elements of soft technologies do not necessarily combine in synergistic relationships and practical compromises can, and do, sometimes need to be made. Adler (1993), and Adler and Cole (1993), also address the issue of standardisation of work and the development of a committed and empowered workforce. In these landmark articles based on the experiences of NUMMI and Uddevalla, Adler and Cole (1993), argue that organisations responsible for highly repetitive operations need the consistency and discipline provided by bureaucracy and that these firms should not strip organisational bureaucracy, but rather, redesign it to support high levels of employee motivation, commitment and creativity. They also indicate that in order to redesign organisational bureaucracy, firms need to be able to differentiate between coercive bureaucracy, that designed for assuring compliance and enabling bureaucracy, a codified set of practices to guide organisational learning and team development. Coercive and enabling bureaucracies are based, respectively, on Douglas McGregor's (1960), theory X and theory Y of human behaviour and motivation. The key implication of their work is that in highly repetitive operations the adoption of management policies and technologies that provide the necessary level of employee support and ensure the necessary level of employee involvement can lead to world class standards of performance. Put differently, highly proceduralised and standardised job roles can coexist with a high employee empowerment work environment. In this context, employee empowerment, and therefore soft management technologies, focus on team and personal perspectives such as hire and fire, promotion and skills development, rather than technical perspectives.

While there is general agreement on the importance of soft integration it has proven an illusive concept to measure. There have not been any large scale, broad studies of soft integration, and therefore no generalizable measure exists. Perhaps the best overview of soft integration is provided by Twigg, Voss and Winch (1992) which is given in Table 2.2. Their analysis of fifteen companies which use CAD/CAM technologies focuses on linkages between engineering and manufacturing. They propose a set of linkage mechanisms which are all types of soft integration. For example, direct contact can be encouraged through design reviews, ad hoc meetings or informal contact, such as in coffee lounges etc. Secondment, termed job rotation by Jaikumar (1986), involves rotating employees between manufacturing and engineering (or other functions) in order to broaden their perspective of the organisation as a whole.
### Table 2.2  Linkage Mechanisms

<table>
<thead>
<tr>
<th>Linkage Mechanism</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Direct Contact</td>
<td>Meetings, design reviews, informal contact in social settings etc. can help to integrate different functional areas within a firm.</td>
</tr>
<tr>
<td>Physical Proximity</td>
<td>Office changes and relayout can be used to put employees from different groups together and encourage open communication.</td>
</tr>
<tr>
<td>Decision Rules in Software</td>
<td>In this case, decision rules are built into software to reflect the concerns of downstream functions.</td>
</tr>
<tr>
<td>Electronic Mail</td>
<td>the use of computers as a communication medium for exchanging ideas and information.</td>
</tr>
<tr>
<td>Liaison Roles</td>
<td>Consist of two types. First, in pairs a person in one function (engineering) has a direct liaison in another function (manufacturing). Second, a particular group within one function may also report to another function.</td>
</tr>
<tr>
<td>Secondment</td>
<td>Involves the temporary assignment (from 3 months to two years) of a person from one function to another.</td>
</tr>
<tr>
<td>Task forces</td>
<td>Usually responsible for the implementation of policies rather than policy formation.</td>
</tr>
<tr>
<td>Project Teams</td>
<td>Cross-functional and are longer term in nature than task forces.</td>
</tr>
<tr>
<td>Role Combination</td>
<td>the combining of several types of tasks previously performed by separate people under a single category of worker (ie. the opposite of specialisation).</td>
</tr>
<tr>
<td>Permanent Team or Cell</td>
<td>Involves people from different functional areas forming a permanent project team organised around a common database.</td>
</tr>
<tr>
<td>Integrator Function</td>
<td>Same as a liaison, but on a larger scale.</td>
</tr>
<tr>
<td>Combined Department</td>
<td>Common databases allow several functions to be combined into one.</td>
</tr>
<tr>
<td>Matrix Organisation</td>
<td>People working on a project or task will remain in their department reporting functionally on technical matters but reporting generally to a project manager.</td>
</tr>
</tbody>
</table>

Note: Based on Twigg, Voss and Winch (1992)
2.14 Pillars of Manufacturing Excellence

Recent Advanced Manufacturing Technologies such as JIT, TQM and CIM are viewed by many (Gunn (1987); Ciampa (1988); Hugh and Anderson (1988); Hayes and Wheelwright (1984); Beckman (1990), Schonberger (1982, 1986); Hall (1986,1988) ) as the "pillars of manufacturing excellence". These researchers have indicated that, when these technologies are successfully implemented, customers, firms, and the economy in general will realise numerous benefits. JIT, TQM, and CIM are not goals in themselves, (Suzaki, 1987), rather, they are tools to achieve goals. Schonberger (1986) argues that the successful adoption and implementation of these tools will provide firms with a competitive edge, yield synergetic effects in all subsystems of the firm and increase both the efficiency and the effectiveness of the operation.

Gunn (1987), developed a manufacturing competitive framework based on the three pillars of excellence which is shown in Figure 2.9. This framework consists of four planes: the strategic plane, the manufacturing resource plane, the integrated manufacturing plane and the pillars of excellence plane. The strategic plane is concerned with the development of the business unit strategic vision which is based upon two frames of reference: global markets and global competition. The manufacturing resource plane represents the critical management systems necessary to achieve world class manufacturing status and the realisation of the vision. These systems are quality, people, proven technology and planning. Challis and Samson (1996B), identified similar systems as the key drivers of competitiveness from the detailed analysis of the practices of a number of Australian manufacturing firms. Three of the four systems they identified: structural (strategic orientation and energisation), quality and human resources are virtually identical to Gunn's strategic quality and people systems. The fourth, capabilities, is concerned with management technology (Badawy, 1993) rather than technology per se as depicted in Gunn's model. Challis and Samson (1996B) considered technology as more of a qualifier rather than discriminator of manufacturing performance as the manufacturing industries that formed their sample population did not generally use proprietary technology. The third level of the model is the integrated manufacturing plane which considers both suppliers and customers as part of the production process. According to Gunn, (1987), integration need occur along two orthogonal axes: the order to delivery axis and the customer/supplier axis. Gunn (1987), also argues that suppliers and customers need to be involved in each of the 5 key processes in the order to delivery cycle: product and process design, manufacturing planning and control, production processing, distribution and after sales service and support. The fourth level of the model is the three pillars of excellence, TQM, JIT and CIM that support the integrated manufacturing plane. The model represents TQM, JIT and hard AMT as each being of equal importance implying that all three should be addressed simultaneously in any manufacturing improvement program. The model also implies that if any one pillar is missing, the foundation is unstable.
FIGURE 2.9
PILLARS OF MANUFACTURING EXCELLENCE

Source: Gunn (1987).
2.15 World Class Manufacturing

The term World Class Manufacturing (WCM) has been used widely by many academics and practitioners. Hayes, Wheelwright and Clarke (1988), define WCM as "being better than almost every other company in your industry in at least one important aspect of manufacturing". Hayes' et al's definition has many implications. To become a WCM, firms must clearly articulate the dominant capabilities that constitute their competitive advantage, then align their manufacturing operation and organisation with this intent by a suite of structural and infrastructural decisions. Hayes et al have catalogued structural decisions as: (1) the total production capacity; (2) the breakdown of production capacity between facilities; (3) production equipment and systems, and (4) the make vs buy (Samson, 1991, pp. 182) of materials, systems, and services. Infrastructural decisions refer to management systems, processes and policies and include: (1) human resource policies; (2) quality assurance and control policies; (3) production planning and control systems; (4) new product development processes, including capital allocation systems; (5) performance measurement and reward systems, and (6) organisational structure and design.

The second implication of Hayes' et al's definition is that world-class companies are Stage IV companies. Hayes, Wheelwright and Clarke (1988) described the Passage to world-class manufacturing status as a four stage continuum. In Stage I, companies consider their manufacturing organisation to be internally neutral. These companies produce product as long as the firm's marketing function can sell it. The implications of this philosophy include a low employee commitment to quality and the elimination of waste and inadequate or inappropriate managerial actions and decisions in response to competitor movements. In Stage II, companies view their manufacturing organisation as externally neutral. Stage II companies are aware of competitors by finding themselves forced to adhere to standards imposed by them. The implications of this philosophy include emulation of competitor behaviour and a recognition that quality and costs are important considerations in improving manufacturing performance and assuring the viability of the business. In Stage III, manufacturing organisations are considered internally supportive of other company functions. In these companies, management recognises the value of synergies between organisational elements, including manufacturing. Hayes indicates that the success of a stage III company is a function of it's ability to use the available resources more effectively than competitors. In Stage IV, companies view their manufacturing organisation as externally supportive. The implication of this philosophy is that the firm's manufacturing capabilities are a key driving force in the development of competitive weaponry. Stage IV companies have achieved extensive organisational synergy and world class standards in all areas of performance.

The third implication of Hayes et al's definition is that WCMs are more inclined to have higher growth rates and be more profitable than their competitors. Hayes et al indicate that this
is reflected in operational attributes that include responsiveness to product and market shifts, designing products that are difficult for competitors to replicate or substitute, institutionalised continuous improvement and employees who's services are so valuable that competitors are continually seeking to attract them into their organisation.

Gunn (1987), indicated that the following benchmarks are indicative of world-class status: (1) an inventory turnover of at least 25 to 30 per annum; (2) fewer than 200 defective parts per million for any product manufactured; and (3) a ratio of value added lead time to total manufacturing lead time in excess of 0.5. Gunn (1987), indicated that these requirements are generally beyond the reach of most manufacturers at that time. For example Ford, one of the best managed companies, had an inventory turnover of 10.2 per annum (Montgomery, Gooch and George, 1987). Gunn (1987), also argued that the requirements to become world class will become more stringent in the future. His work also considers the effects of WCM on the organisation and its members. Gunn (1987) concludes that its implications include a refocusing on core business drivers rather than functional needs, reduced hierarchy, increased job breadth, increased devolution of responsibility, more open communication, increased planning and a recognition of the strategic value of information.

Huge and Anderson (1988), trace the evolution of world-class manufacturing and analyse how Japanese companies had, by developing a high level of co-operation and collaboration between management and employees, overcome gross disadvantages to gain world leadership in manufacturing. They indicate that new world-class firms must achieve lower cost, higher quality, greater flexibility, and innovative product and process technologies and argue that these requirements can be mutually reinforcing and not mutually exclusive as argued by a number of earlier researchers (eg Skinner 1969, 1974, Hayes and Wheelwright, 1984). Huge and Anderson (1988), also argue that world class firms are characterised by two important attributes. First, they acknowledge that to achieve sustainable success requires an effective employee empowerment (Walton, 1985) philosophy that engages all available resources. A philosophy, as defined in this context, refers to a set of values and principles that guide the actions of all employees in the pursuit of the firm's goals and strategies. In their opinion, an empowerment philosophy unites people, gives meaning and purpose to their efforts, and guides decision making processes throughout the firm effectively linking the "top floor" with the "shop floor". Second, the selected manufacturing strategy must be consistent with the firm's competitive strategy and support the competitive effort of the firm as a whole.

Huge and Anderson (1988), like many other practitioners, believe that the philosophy of manufacturing excellence should include TQM and JIT. Furthermore, they argue that a paradigm cultural change must take place for these two interventions to be successfully implemented. Huge and Anderson (1988), define this cultural change by articulating a set of practices: (1) stopping production for quality problems; (2) eliminating all inventory; (3) manufacturing only "to order" and (4) using valid, and appropriate sets of performance
measures that support the achievement of the firms objectives and goals. In terms of employee behaviour, huge and Anderson (1988), indicate that this cultural change will be reflected in leadership, knowledge, enthusiasm, will, and energy.

Clark, Hayes, and Lorenz (1985) argue that the principal requirements for success as a WCM is the ability to efficiently produce high quality products in an operating environment characterised by rapidly changing customer demands. These researchers develop a number of requirements that need to be met for a company to qualify as world-class. These include: high quality products and services, minimal inventory, effective and appropriate manufacturing technology, innovative workforce management policies and new product development policies and global sourcing of components and materials.

Clark, Hayes, and Lorenz (1985) also indicate how, in their opinion, each of these requirements can be achieved. High quality can be realised by: (a) designing quality into the product, (b) developing zero-defect goals for both suppliers and production, (c) introducing an effective preventive maintenance program for key plant and equipment, and (d) simultaneously considering the design and manufacturability of new products to avoid developing products that cannot be reliably produced. Minimum inventory can be achieved by (a) reducing set up times to avoid large batch sizes, (b) implementing JIT production and JIT delivery systems, (c) minimising the travel distance and transit time of products in the factory, (d) eliminating “just in case” stocks caused by uncertain quantity and delivery from various stages in the production process. Manufacturing Technology developments should consider (a) the use of computer integrated manufacturing techniques such as computer aided design, robotics, flexible manufacturing systems, (b) the application of technology to enhance flexibility, increase quantity, and reduce inventory, and finally, (c) to ensure that technological investments focus on the ultimate goal of making small-batch manufacturing as efficient as mass production. Innovative workforce management policies should (a) facilitate employee participation; (b) encourage the use of quality circles to address production issues; (c) seek to eliminate restrictive work practices; (d) increase employee skills and responsibilities; and (e) provide bonuses and incentives in recognition of productivity enhancement. In the new product development process, Hayes et al indicate that the penultimate goal must be to minimise the total elapsed time between launching a new product and its commercial introduction. Also, product availability must match customer demand. Finally, to be able to correctly evaluate make vs buy decisions, a firm should explore its capabilities for mass production in low cost facilities and completely understand the marginal cost of production at each operating facility.

Schonberger (1986), summarises the overriding goal of a WCM as continual and rapid improvement in all key business areas. Schonberger (1986), also indicates that a key issue that firms need to address in order to achieve world class performance was to break out of the trade-off mindset (refer also 2.8) that has dominated manufacturing thinking during the last two decades. He indicates that there is “wide agreement among WCM that continuous
improvement in quality, cost, time and customer service is possible, realistic and necessary." He also develops a change agenda to close the gap to WCM performance. This agenda is prepared in the form of a set of practices (Schonberger, 1986, pp. 217). Practices include: get to know the customer, cut work in progress, cut process flow time, rationalise the number of suppliers, develop workforce skills and cost effective and realistic use of technology.

In summary, many different researchers have identified plans and actions to achieve and sustain world class standards of manufacturing excellence through the development, integration and exploitation of a set of order winning capabilities, practices and attributes. However, although there is widespread understanding and acceptance of the construct and its underlying concepts, like human resource management practices many firms have been unable to put them into practice (Challis and Samson, 1996B). As noted by Samson (1991):

"...the state of leading edge knowledge is reasonably well developed in content but substantially underdeveloped in process : that is an articulated set of steps or principles to guide the realisation of the necessary changes."

This dissertation makes a contribution toward closing this gap by identifying and analysing the activities and processes of major manufacturing firms pursuing world class standards of performance.

2.16 Best Practice

One of the pioneering works in the development of best practice concepts was the MIT study, (MIT, 1989). From the analysis of the best performing firms in 8 industrial sectors, six key principles for success were identified:

- synergy: a focus on simultaneous improvement on cost, quality, flexibility and delivery
- customers: closer links with customers
- suppliers: closer relationships with suppliers
- technology: the effective use of technology for strategic advantage
- structure: less compartmentalised and hierarchical structures
- human resources: human resource policies that promote learning, teamwork, participation and flexibility

This work served to define the agenda for best practice, defining the areas which enterprises should develop to improve their competitiveness (ACBP, 1995). Further work by MIT (1989), was concerned with identifying the conditions or practices which support the operationalisation, organisational diffusion and sustainability of these principles. These include the development of an integrated manufacturing concept, upskilling of employees, involvement of customers in the product development process, processes for enhancing employee involvement and commitment, organisational restructuring and work redesign and the
development of strategic processes that effectively balance short and long term requirements (MIT, 1989).

Today the term “best practice” is widely used and has many different definitions. One of the most comprehensive definitions has been developed by the Australian Manufacturing Council (AMC) following a review of key domestic and international literature (Ernst & Young American Competitiveness Study, 1993, Made in Britain, 1992, Australian Manufacturing Council) and criteria applied in the major quality awards of Australia (Australian Quality Council, 1994, Australian Centre For Best Practice, 1995), the United States (Malcolm Baldrige National Quality Award, 1994), Japan (Deming Prize Criteria) and Europe (European Quality Council, 1993). The Australian Manufacturing Council’s definition of Best Practice (Australian Manufacturing Council, 1994A, 1994B) is:

"....the cooperative way in which firms and their employees undertake business activities in all key processes: leadership, planning, customers, suppliers, community relations, production and supply of products and services, and the use of benchmarking. These practices, when effectively linked together, can be expected to lead to world class performance outcomes in quality and customer service, flexibility, timeliness, innovation, cost and competitiveness."

This definition clearly indicates that Best Practice is concerned with how to achieve exemplar outcomes rather than identifying what those outcomes should be. Therefore, best practice does, to some degree address a key limitation of other manufacturing excellence paradigms (eg. world class manufacturing).

The Best practice construct also stresses two key elements. First, best practice emphasises human resource based contributions toward competitive advantage (Australian Manufacturing Council, 1994A, 1994B). Best practice firms recognise that sustainable improvements in performance and competitiveness require levels of commitment, co-operation responsibility and knowledge on the part of the workforce that cannot be obtained by compulsion or cosmetic improvements in human resource strategies. This recognition is reflected in the investments that these firms make in developing innovative human resource policies that promote participation, teamwork, trust, flexibility, employment security and a sharing of economic risk. These requirements are also reflected in MIT’s (1989) analysis of quality programs:

"...quality initiatives do not work unless employees understand the overall production process and unless their wages, job security or profit sharing arrangements give them a sense that they have a stake in the firm's future. The most successful firms recognise that quality is the output of an entire production system and not the results of an organisational gimmick." (MIT, 1989, p 18).
Best practice firms also recognize the role and value of leadership in changing the attitudes, values and mindset of the workforce. By building shared vision, actively challenging the way that work is performed and gaining the commitment of employees to the change process, leaders play a key role in the pursuit of Best Practice (Australian Manufacturing Council, 1994A, 1994B). Similar observations were made by Walton (1985), in studying the progression from a control to commitment based organisational culture. From extensive experience as an organisational change consultant, Davies (1993), also observed the existence of a shared performance related vision underpinned the pursuit of best practice and that many firms failed to translate their vision into reality because of leadership deficiencies.

Strebel (1994), argues that many attempts to pursue best practice fail because they place excessive emphasis on change drivers and inadequate emphasis on addressing the barriers to change. Strebel identified closed mindsets and entrenched cultures as key forms of organisational resistance and indicated that in those instances where the forces for change are relatively weak, organisational resistance becomes a key consideration requiring neutralising strategies to be developed and implemented. Many authors including Klein, 1984, Gilmour and Landsbury, 1985, Dawson, 1990 and 1991, Curtain, 1990, Alexander and Green, 1992 and Samson, 1993 have commented on the reluctance of many middle managers to support the implementation of best practice initiatives as they often perceive that change will diminish their prospects, relevance and power. The Australian Manufacturing Council (1994A), also indicated that of the 14 barriers to improvement evaluated in poorer performing firms, the ability to implement change by middle management was the largest.

Second, best practice recognises that the various innovations implemented are not independent solutions, but rather, a coherent integrated package of changes. The following statement provides an illustrative description (AMC, 1995):

"... Competitive benchmarking, team based approaches to product and process development, closer relationships with customers and suppliers, increased emphasis on customer satisfaction, flatter organisations, increased sharing of information, employee involvement in decision making, profit sharing, increased job security, a commitment to training and continuous improvement - each of these features reinforces the other and the entire organisation is affected by them..."

The AMC illustrate the integrative nature of best practice by representing the construct as a jigsaw (Australian Manufacturing Council, 1994A). In this representation each piece must be in place and effectively linked with the others. The absence of even a single piece makes the picture incomplete and threatens the long term structural integrity of the finished puzzle and employee practices are the critical central piece that is linked to each and every other piece.

It is noteworthy that there is no universally accepted gestalt of practices that constitute a best practice ideal. Different organisations and individuals appear to apply different
terminologies, group practices differently and consider different elements although there are some core areas of commonality. For example, the AMC model (Australian Manufacturing Council, 1994A) includes the elements of leadership, customer focus, benchmarking, manufacturing strategy, technology, quality and a number of employee practices including training and development, communication, occupational health and safety, skills development and remuneration. The model used in "Made In Britain" (IBM/LBS, 1995) uses the elements of quality, lean production, logistics, teamwork and empowerment, manufacturing strategy, technology and concurrent engineering. The MIT model (MIT, 1989) uses the elements of quality, customer and supplier relationships, structure and roles, technology and human resource policies.

Finally, there has been very little empirical work performed that objectively evaluates the value of various practices in respect to improvements in manufacturing performance. One notable exception is the work of Dow, Ford and Samson (1996), who analysed the impact of eight different practices on quality performance. These eight practices were employee commitment, customer focus/planning, teams, training, Just In Time, supplier relations, benchmarking and Advanced Manufacturing Technologies. These authors used a large stratified sample of 1289 Australian and New Zealand manufacturing firms. Dow, Ford and Samson (1996) found that only two of the eight constructs were related to improvements in manufacturing quality. These two constructs were employee empowerment and customer focus/planning. This dissertation makes a significant contribution in this area by developing various practice constructs including measures and scales and subsequently evaluating the relationship between these practices and hard and soft measures of manufacturing performance.

2.17 Integrated Manufacturing

In their landmark article, Dean and Snell (1991) proposed that TQM, JIT and hard aspects of AMT comprise a new manufacturing paradigm which they termed Integrated Manufacturing. The core thrust of IM is that TQM, JIT and hard AMT can work synergistically to create a streamlined high quality production system that transforms raw materials into finished products, uninterrupted by logistical impediments (Mortimer, 1985). Dean and Snell (1991), and Snell and Dean (1992), believe that firms that effectively adopt IM can integrate three different operational perspectives: activities (termed stage integration) and functions (functional integration) and goals (goal integration).

Dean and Snell (1991), indicate IM facilitates stage integration by applying practices that are integrative from the perspectives of time, space and information. Functional integration is encouraged by the application of "boundary spanning technologies", the development of a unifying foci (quality improvement and time compression), the use of teams and collaborative
problem solving processes. Goal integration is also supported as IM recognises the synergies between quality, cost and other key performance areas such as flexibility and responsiveness. The logic that underpins goal integration is radically different from the logic of tradeoffs among strategic goals that it replaces (Susman and Dean, 1989). The concept of goal integration has been strongly supported by many researchers (Crosby, 1979, Schonberger, 1986, Bolwijn and Kumpe, 1990, Ferdows and De Meyers, 1990).

IM is primarily concerned with the integration of IM facets (TQM, JIT and hard AMT) from a human capital perspective (Snell and Dean, 1992) and has strong parallels to the work of Gunn (1986), Mortimer (1987), and Ramsay, Samson and Sohal (1991). Empirical work related to the construct can be largely ascribed to Snell and Dean. Due to the embryonic stage of development of the paradigm, research performed to date has principally been of an exploratory (Yin, 1989) nature. Research performed has focused on the relationship between IM facets and various human resource practices. In some instances, interactive effects have been considered. Facets of IM have been found to be positively related to job design but only when sources of organisational inertia such as size and performance are considered (Dean and Snell, 1991). Facets of IM have been found to be generally positively related to the investments firm's make in the human resource management practices of recruitment, training, appraisal and rewards (Snell and Dean, 1992). Facets of IM have also been found to be positively related to various compensation practices (group based incentives, salary and seniority pay) but only when job characteristics reflect "knowledge work". (Snell and Dean, 1994). Two and three way interactive effects have shown widely varying results with a mix of negative, not significant and positive effects noted. Sample populations varied from 90 to 123 firms with data collected from three different sources (Plant Manager, Functional Manager, Quality Manager) for each measure. Measures demonstrated good interrater reliabilities (a range of 0.68 to 0.98, exceeding 0.80 for in excess of 85% of all variables). All sites surveyed were in the United States.

Balan (1994) investigated the relationship between IM facets, both individually and interactively, and various competitive performance measures used within manufacturing (cost, quality, delivery and flexibility). All sites were within New Zealand. Sample population was 35 with data collected from the same three respondent classifications used by Snell and Dean (1991, 1992). Interrater reliabilities were not calculated and separate analyses were conducted on the three different data sets. From a qualitative standpoint, the results of the analysis indicated a high degree of consistency as demonstrated by the individual beta values and the change in adjusted $R^2$ across each data set. Results obtained were mixed with some competitive performance categories (eg. cost and quality) demonstrating significantly stronger associations with IM facets than others. Also, the contribution of individual IM facets was not
consistent across competitive performance categories and where elements did contribute it was not in the categories expected. For example, TQM positively and significantly contributed to cost but not to quality. JIT positively and significantly contributed to quality but not to delivery or flexibility. Three way interactive effects tended to be positive and large. Two way interactive effects were not evaluated. Balan (1994), concluded that there was some degree of general support that IM did contribute to firm performance but much further work was required to develop more generalisable conclusions (Balan, 1994, p164) particularly in view of the small sample size (Balan, 1994, p162).

2.18 Justification Of Hard AMT Investments

As noted earlier, the processes of justification are not germane to the questions proposed in this study, but for completeness of understanding, will be briefly discussed. It is not possible to assess and evaluate the strategic and operational value of hard AMT investments without a sound understanding of the basis on which those investments were made.

A substantial stream of research addresses the challenge of developing suitable processes and methods for evaluating proposed investments in new technology. One of the first realisations that managers came to regarding investments in hard AMT was that justification is a fundamentally different process to that used for the more traditional, established technologies.

Authors who have studied the difficulties of applying traditional justification processes and methods to hard AMT's include Hayes and Abernathy (1980), Gerwin (1982), Gold (1982), Rosenthal (1984), Kaplan (1986), Meredith (1986A, 1987A, 1989), Farley, Kahn, Lehman and Moore (1987), Adler (1988), Nemetz and Fry (1988) and Hayes and Jaikumar (1988). The following is a short synthesis of their collective ideas. There is general concurrence that the primary difficulty in justifying hard AMT investments is that the unique benefits which hard AMTs offer are relatively soft and difficult to quantify. Soft benefits include better quality, improved flexibility, reduced inventory and less floor space. Researchers have also noted, that the preoccupation of managers toward analytic techniques tends to bias decisions against investment in hard AMTs which have greater risk and uncertainty, longer timeframes and less quantifiable benefits than those offered by the more traditional technologies. Put differently, hard AMT's do not readily conform to the requirements and assumptions of traditional capital evaluation methods such as discounted cash flow (DCF), net payback or labour savings. For example, one of the benefits of hard AMT's is that their useful life is enhanced because they possess the capability to adapt to new products and features. In contrast, more dedicated equipment such as transfer lines in an automobile engine plant is developed for a single product and must be overhauled when a major product redesign occurs. Another difficulty encountered by firms in justifying hard AMT's is the difficulty of accurately estimating the dollar value of the required investment due to unknown (and often unforeseen) costs associated with
the development of administrative systems, people and infrastructure associated with the hard AMT investment. Kaplan (1986), argues that firms need to separate the tangible and intangible costs and benefits of hard AMT investments. He considers that the key challenge to managers, is to develop better means of quantifying benefits and to incorporate these criteria in their justification procedures.

Canada and Edwards (1987), argue that the difficulties of hard AMT justification are compounded by high hurdle rates for investments, and short term managerial mindsets, and as a consequence many hard AMT proposals are unduly dismissed. In an article on the strategic aspects of hard AMTs, Goldhar and Jelinek (1985), also indicate that older methods of capital evaluation "ignore the strategic, integrative character of the new technology" (p. 102). The implication of their statement is that new justification procedures must be developed which can adequately capture the qualitative (as opposed to quantitative) benefits of hard AMTs. The justification method proposed by Kaplan (1986), involves evaluating both the tangible and intangible benefits of hard AMTs, and developing more accurate methods for evaluating the dollar value of the intangible aspects of hard AMTs. A different approach is suggested by Meredith and Hill (1987), who examine four levels of integration ranging from stand alone equipment, stage 1, to full integration or CIM, stage 4. They recommend that a different justification technique should be used for each level of integration, with the level of sophistication of justification techniques increasing with the level of sophistication of the systems evaluated. Merideth and Hill (1987), note that few companies have achieved the higher levels of integration (stages 3 and 4) and imply that this may be due in part to the difficulties involved in justifying more integrated systems with traditional capital evaluation methods. A similar examination of justification techniques is offered by Merideth and Suresh (1986), who describe a three stage taxonomy: 1) economic, primarily used for standalone systems, 2) analytic, used for systems with economic and non economic benefits and risks and 3) strategic, appropriate for systems which contribute directly to the firm's business objectives. Other justification techniques are offered by Bennett (1985), Swamidass and Newell (1987), Lefley (1994), and Balan (1995). Balan (1995), also notes that by their very nature, the benefits, costs and risks associated with hard AMT's vary significantly and it is therefore unlikely if any single justification method will be appropriate for all, or even a wide range, of hard AMT projects.

2.19 Limitations

In this chapter we have considered the development of the literature related to AMT from a number of different perspectives. Since the inception of hard AMT's, there has been a stream of literature that posits that their introduction needs to be accompanied by changes to organisational and human resource systems. This research has been primarily conducted by the use of exploratory case studies that focus on changes to a number of key attributes over
time. These attributes include organisational and work group structures, teams, manager's and worker's job roles and responsibilities, skills development, communication processes and employee involvement processes. This work has served to identify a number of critical elements of the change process, build a strong theoretical foundation and develop a number of methodological tools (e.g. constructs). Consequently, a sufficient body of knowledge has been developed to now enable meaningful examination of a large population of manufacturing firms. However, this analysis has yet to be performed.

Researchers have also considered the linkages between hard AMT usage, performance and a firm's competitive strategy arguing that hard AMT's improve a range of performance outcomes, increase the scope of differentiation possibilities and reduce the costs traditionally associated with economies of scope. Researchers such as Merideth, (1987A, B, C, D) and Bessant (1994) have undertaken detailed case studies of numerous sites and proposed a range of hard AMT benefits ranging from, reduced floor space and scrap to increased profitability and capacity. However Balan (1994, pp. 28) notes a key research limitation:

"The fact that many hard and soft AMT's are relatively new and experience with their implementation has been limited, the associated benefits, risks and costs are blurred. Research is needed to pinpoint more accurately what to expect and gain in each of these areas by studying organisations that have implemented various AMT projects."

There has been little empirical work that examines the relationship between hard AMT and strategy with the possible exception of the work of Nemetz (1989). She demonstrated that hard AMT can permit manufacturers to simultaneously pursue multiple competitive priorities and inferred that firms with ineffective strategies and strategic management processes are less likely to derive these benefits. However this is also yet to be proved in practice.

A large body of research has emerged during the last two decades (and in particular during the last decade) that is concerned with evaluating the relative merits of JIT and TQM and identifying the "conditions for success." Most research has been case study based and has concluded that TQM does improve organisational performance. A number of researchers have indicated that the extent of improvement is debatable as most of the research has been conducted by consulting firms with a vested interest in outcomes and the research does not generally conform to established standards of academic rigour (Powell 1995). No doubt the different definitions ascribed to, and theoretical foundations associated with, both JIT and TQM have also substantially contributed to this debate. Further, most quantitative work that has been performed has applied small sample frames. When coupled with a lack of broadly accepted definitions for both TQM and JIT, the use of small sample frames has resulted in different sets of measures being used by different researchers to operationalise these constructs. This creates a further limitation when comparing and contrasting the results of research in this area. There clearly exists an urgent need to develop broadly accepted definitions and measurement
sets for these constructs. This will assist in ensuring that future research is "cumulative" rather than "dispersive", thereby enabling many of the current knowledge shortcomings to be addressed and overcome.

A further limitation in the development of the AMT literature as defined in this work relates to the type and form of Human Resource Management (HRM) practices that contribute to improvements in firm performance. In terms of research activity, most work in this area has concentrated on the development and "value" of specific HRM practices, eg. teams, remuneration, recruitment, benchmarking and employee involvement. A focus on individual practices however, presents both theoretical and methodological dilemmas. Dow, Samson and Ford (1996), found the correlations between 8 HRM practice constructs to be all positive and statistically significant supporting the view that HRM practices are usually found in combination. Therefore, to the extent that the presence of any single practice reflects a firm’s wider propensity to invest in other practices, estimates of the impact of a particular practice on firm performance will be upwardly biased. This degree of interdependency between practices implies that the unit of analysis for assessing the impact of practices on performance, needs to be a “bundle” of practices rather than a particular practice although relatively little work has been performed in this area. A further limitation is associated with the constructs used to evaluate the “value” of these practices. Most empirical work is concerned with the relationship between HRM practices and employee performance evaluated in terms of productivity, motivation, morale, retention of quality employees and resignation of nonperformers (Jones and Wright, 1992, U.S. Department of Labour, 1993). Therefore a finding that work practices are related to turnover or productivity does not necessarily mean that these practices have any effect on manufacturing performance measured in terms of profitability, unit cost or customer satisfaction.

However, the use of broad based survey type research to overcome the problems associated with interdependencies between practices, needs to consider two key methodological limitations: causality and respondent bias. Causality is of particular concern as many researchers hold the a priori view that practices drive improvements in performance and therefore interpret correlations between practice and performance constructs as supporting their hypotheses or propositions. However it is conceivable that performance may drive investments in practices. Firms that have relatively high levels of performance may not only be more inclined to invest in practices, but also be more able to implement practices as they may have more "spare" resource capability available. If better performing firms are more likely to invest in practices then contemporaneous estimates of the effects of practices on performance will be overstated. Alternatively, it may be that poor performing firms turn to practices as a remedy. If so, then estimates of the impact of practices on performance will be understated. Respondent bias is also of concern as the probability of responding to a survey may be related to both a firm’s financial performance and its level of practice investments. However without
knowing the direction of the relationship between these two variables, a researcher cannot evaluate its effect. These issues of interdependence, causality and respondent bias imply that research in this area should apply a mix of quantitative and qualitative methodologies, an approach which is not generally observed in the literature. We will pursue these issues further in the subsequent chapters.

A number of the issues associated with interdependence have been considered in the various models (eg. World Class Manufacturing, Best Practice and Integrated Manufacturing) to guide manufacturing to world class standards of performance. These models describe characteristics and processes to assist firms in this transformation that are, in general, based on the views of leading scholars, practitioners and institutions in the field, rather than definitive pieces of research. Moreover, two common criticisms and limitations of these models is that they are insufficiently detailed to be readily operationalised and that processes and guidelines need to be developed to assist in their implementation. These limitations imply that field based case study research is needed to improve understanding of the processes of transformation toward manufacturing excellence.

2.20 Chapter Summary

This chapter presented a discussion of the literature related to AMT’s and their use within industry. A definition of AMT was developed that incorporates traditional hardware (eg. CNC and FMS) and software (eg. TQM and JIT) perspectives in addition to other organisational and human resource aspects. The discussion then considered the early literature, which was focused in the domain of hard AMT’s and related their development to manufacturing and operations strategy. The need for AMT to be accompanied with adjustments to organisational and human resource systems was then discussed. It was shown that through detailed case studies, many researchers have argued the implication of AMT investments are far reaching and require very substantial changes in many areas.

The discussion of human resource aspects was then taken further. A separate body of literature that purports AMT to increase the dependency of manufacturing performance on employee performance was then reviewed. A number of researchers were shown to argue that skills development, workforce empowerment, delegation of responsibility, empowerment and acceptance of change were not only key ingredients for the successful implementation of hard AMT but that these capabilities could be applied to drive superior manufacturing performance outcomes. The relationship between hard AMT and strategy was then considered. By presenting the arguments of various researchers it was shown that the appropriate combination of hard AMT’s and strategy can change both the nature of the competitive environment and the ability of firms to compete. In particular it was shown that hard AMT challenges the “focused factory” concept and supports the cumulative model of competitive capabilities.
The rich literature sources associated with three key soft areas of AMT were then discussed: TQM, JIT and Organizational and Human Resource Development. Analysis of this literature would indicate that although there are many theoretical models and prescriptions for success, there is a dearth of rigorous empirical work with which to support them. The review then considered the context in which AMT investments exist by considering three paradigms commonly used to transform manufacturing. These were World Class Manufacturing, Best Practice and Integrated Manufacturing. The empirical work related to each model was also briefly discussed.

A number of limitations related to development of the literature were also discussed. In general, this review indicated that research in many areas of both hard and soft AMT is no longer "pre-paradigmatic" and that there is both a need and an opportunity for research that consolidates the relatively fragmented knowledge base that currently exists. It was argued that this research should apply a mix of quantitative and qualitative methodologies in order to overcome a number of methodological issues, an approach which is generally not currently observed in the literature.
CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter examines the methods and processes used to test the propositions and address the questions posed in this research. These propositions and questions are concerned with a number of aspects related to the adoption, implementation and value of investments firms make in areas of soft and hard AMT and are detailed in Chapter 1. The material in this chapter is organised as follows. Section 3.2 discusses the rationale for applying both quantitative and qualitative methodologies to this area of research. Section 3.3, the largest section in the chapter, discusses a number of issues related to the quantitative analysis. These include: the survey instrument and survey administration, the sample, respondent fatigue, the preparation of the data, the reliability of the measurement scales, content validity, construct validity and limitations. This section also discusses the assumptions associated with the various statistical analysis techniques employed in the analysis. Section 3.4 considers the qualitative analysis. Issues of research questions, qualification and selection of firms, sample size, research process and limitations are discussed in this section.

3.2 Philosophical Basis for Research design

This research seeks to examine two key and complimentary perspectives. First, to examine the relationship between investments in TQM, JIT and hard AMT and aspects of performance including the identification of practice environments that support this relationship. Simply put, this area of research is primarily concerned with identifying “what works” and quantifying its relative importance. This dissertation seeks to examine the value of TQM, JIT, hard AMT and practice investments in a broad based manner which is more generalisable than the small sample, case study-based research approach that dominates the literature. The need for broad based work with generalisable conclusions has been expressed by many researchers and practitioners (Dean and Snell, 1991, Easton, 1993, Powell, 1995) but to date no work has been published in this area. Associated with this lack of generalisable research is also a lack of validated instruments with which to pursue research in this area. This study attempts to address this void. The research uses the Australian Manufacturing Council (AMC) database of manufacturing practices and performance prepared from a large scale survey (Australian Manufacturing Council, 1994) to:

\[1\] It is accepted that the use of a large cross-sectional sample at one point in time can only imply, rather than prove, causality.
• develop scales that measure the constructs of TQM, JIT, hard AMT, 7 key manufacturing practices, employee performance and manufacturing performance and which satisfy established standards of academic rigour,

• evaluate various relationships between these constructs with emphasis on performance related aspects.

This database has in excess of 300,000 datapoints, and includes the responses of 1289 Australian and New Zealand Manufacturing firms to 246 questions on a broad range of issues. The sample has been stratified in order to ensure that it is representative of all industry sectors and firm types, and the number of responses, 1289, represents in excess of 10% of the total population of manufacturing firms in these two countries (Ergas and Wright, 1994). ..

The second area of research is primarily concerned with issues of “how it works”. In particular this research seeks to gather insights into how investments in TQM, JIT and hard AMT and various practices relate to improvements in order winning capabilities and improve understanding of how these relationships develop over time. Hayes and Pisano (1994) support this intent arguing that:

.. “most firms focus on the form of their organisational assets, for example the mechanics of JIT and TQM - rather than on their substance: the skills and capabilities that enable a factory to excel and make it possible for various improvement programs to achieve their desired results. The consequence of this outlook is that managers have tended to view such programs as solutions to particular problems rather than stepping stones in an intended direction. ”

Hayes and Pisano, 1994, pp. 78.

“The companies that are able to transform their manufacturing organisations into sources of competitive advantage are those that can harness various improvement programs to the broader goal of selecting and developing unique operating capabilities.”

Hayes and Pisano, 1994, pp. 86.

A key inference from Hayes and Pisano’s work is that the learning gained from tracing and analysing how these “stepping stones” are put in place and how firms combine them over time to produce tangible improvements in performance will assist in the progression toward Best Practice. A further practical implication is that the magnitude of investment in, and the complexity of, the change effort is often such that a (generalised) survey is unable to capture all the necessary perspectives and further, that the input of many different individuals needs to be solicited in order to develop a truly representative picture. The case study approach also permits issues of causality to be investigated by permitting the linkages between various constructs to be traced over time. These perspectives, focusing on issues of “how”, tracing operational links over time, unravelling complex cause and effect relationships and seeking broad input, rather than quantifying mere frequencies or incidences lend themselves to the use
of the case study methodology (Yin, 1989, pp. 18). A multiple case study design is well suited to this research as it permits a "replication logic" (Yin, 1989, pp. 44.), that is, the logic of treating a series of cases as a series of experiments - each case study serving to confirm or refute the conclusions drawn from the previous ones. It also enables multiple data collection methods (Taylor and Bogdan, 1984, Yin, 1989) to be used.

The opportunity provided by the Department of Industrial Relations to prepare a detailed set of case studies of participants in the Australian Best Practice Demonstration Program therefore created a unique opportunity in terms of access to information and personnel, availability of documentation, program scope, program scale and time of review, to employ this design philosophy. Data collection methods used included in-depth interviews, documentation on company change activities and processes, progress reports (internal and external), responses to background questionnaires, and various rich sources of secondary data including conference papers, trip reports, newsletters, video presentations etc. The research process is discussed further in Section 3.3.4.

3.3. Quantitative Methodology

3.3.1 Survey: Instrument and Administration

The basic instrument used to test the stated hypotheses is the data derived from a 17 page mail survey of Australian and New Zealand manufacturing firms. The survey was conducted by the Australian Manufacturing Council (AMC) with the assistance of the Boston Consulting Group, the Australian Bureau of Statistics and the Manufacturing Advisory Group (NZ). The questions in the survey were developed by a committee of leading academics (including the author's supervisor), site managers and the Chairman of The Australian Quality Awards Foundation. The committee used a number of sources in developing the questions including the Malcolm Baldrige Awards Criteria, the Deming Prize Criteria, Ernst and Young American Competitiveness Study, Australian Best Practice Demonstration Program Criteria, Made In Britain and the AMC Emerging Exporters Criteria. The committee also considered models of competitiveness developed for similar studies and performance indicators used by world class enterprises to measure and drive performance (Australian Manufacturing Council, 1994A).

More specifically, the survey instrument was developed around a Best Manufacturing Practices Model (Figure 3.1) prepared by the committee. Of the 246 questions, approximately 20% were concerned with aspects of strategy, 40% with aspects of practices, 20% with aspects of performance and 20% with general company and business information. The questionnaire was pilot tested on 6 sites in Australia and subsequently revised. During January 1994 it was sent to the site managers of some 3000 Australian and 1000 New Zealand Manufacturing firms. All responses were returned over a 10 week period.
Figure 3.1
Best Manufacturing Practices Model
Best Manufacturing Practices Model


- The Manufacturing Strategy module focuses on aspects of planning, structure and operations. It captures strategic management decisions reflected in comprehensive and structured planning, and the alignment of operations with the central business mission. It also looks at the site's source of competitive advantage and the nature and structure of its factory operations.

- The Practice module identifies the range of practices that translate a site's strategy into action. It identifies the six elements of practice that must be addressed: leadership, people practices, customer focus, quality of process and product, benchmarking and technology.

- The Performance / Outcome module identifies the outcomes used to assess the effectiveness of improvements in practices and to inform strategy decisions.

There is an important distinction between the outcomes in the third module and the concept of business performance. 'Outcomes' refers to operational measures, such as quality and flexibility, which are within a firm's control. 'Business performance' refers to financial measures such as sales, exports, cash flow and employment. These will be influenced by many factors external to the firm - for example, its competitive position in markets, the impact of exchange rates on international competitiveness, and the like.
3.3.2 Sample

The sample population is a stratified random sample drawn from manufacturing sites which employ more than twenty people and were registered with the Australian Bureau of Statistics or Statistics New Zealand in 1993. For each country, the sample was stratified using twelve two digit industry codes (ASIC and NZIC) and three size categories ("small" 20 - 49 employees, "medium" 50 to 99 employees and "large", greater than 100 employees). Sampling frames were designed to ensure that all 36 cells had a minimum number of respondents. For the Australian sample each cell contains a minimum of 15 respondents.

Of the 4000 questionnaires dispatched, responses were received from 1289 sites: 962 in Australia and 327 in New Zealand, representing yield response rates of 32% and 38% respectively. A telephone survey of 108 non respondents was conducted by the AMC. These non-respondents were asked a sub-set of questions that had high predictive validity for the rest of the questionnaire. No significant response bias was detected (Australian Manufacturing Council, 1994A).

3.3.3 Respondent Fatigue

Given the number of questions and the fact that some of the terms used in the survey may have been unfamiliar to the respondents, there was concern that the quality of the results may have been affected by respondent fatigue. Two different approaches were used to test for this:

- first, where similar questions were asked in different parts of the questionnaire, the correlation between the responses was checked. This was of particular interest where a question was asked near the start of the questionnaire where respondents are "freshest" and near the end of the questionnaire when respondents may be fatigued.
- second, where the tone of a question is different from that of the surrounding questions, the correlation between responses was checked to see whether the respondent was alert to the changes in scale. For example where the reply structure for the question at issue is such that "better" is a lower value and the surrounding questions involve replies where "better" is a higher value, correlations were checked.

Ergas and Wright (1994), checked the associations between all relevant questions and concluded that the associations were such that it was reasonable to conclude that the length and complexity of the instrument had not seriously eroded the quality of replies.

Ergas and Wright (1994), also checked the quality of responses by examining the concordance between firm's rankings of their performance on Likert type scales with the rankings that emerge from quantitative performance indicators. For example, 8.1% of firms considered themselves to be among the technological leaders in their industry. Analysis of
other data showed that these firms also are more likely to export and do more R & D. Again they found no data to indicate that respondent fatigue was statistically significant.

3.3.4 Data Preparation

There are three distinct stages of data preparation required prior to conducting the main analyses.

3.3.4.1 Data Preparation Stage 1: Measures

The first stage involves the selection of questions to include in the final data set. The diverse nature of the organisations involved in this study, the diverse set of issues addressed by the questions and the depth of information gained in certain areas (e.g. benchmarking) resulted in many of the survey questions not being relevant to the propositions considered. The vast majority of questions employed 5 point Likert scales with a relative few (e.g. firm size and extent of training) employing absolute measures of performance. Scales generally required the respondent to indicate the extent to which he/she agreed or disagreed with each statement and ranged from strongly agree to strongly disagree.

For the purposes of this research, questions were grouped into four sets of factors: IM facets, employee performance, manufacturing performance and practices. The total number of variables used was 72 and a list of the questions used to measure each construct, including factor loadings and reliability measures, is provided in Table 1.

3.3.4.1.1 IM Facets (hard AMT, TQM, JIT)

Previous work in this area has tended to measure facets of IM in relative isolation (Meredith, 1987C, 1989, Ettlie and Penner Haun, 1992, Gunn, 1987, Schronberger, 1986) without addressing how the techniques form a theoretical construct. The notable exception being the work of Dean and Snell (1991), and Snell and Dean (1992, 1994) who developed scales for hard AMT (18 questions), TQM (10 questions) and JIT (5 questions). In this study a total of 33 questions were used to assess these three constructs. Hard AMT was a 12 point scale measuring the extent of use and perceived contribution of integrated computer technologies for manufacturing without considering their relative prevalence across industries. The domain of technologies covered by this definition had many similarities to the 18 item construct developed by Dean and Snell (1991). Both definitions embrace design based technologies (e.g. CAD and CAE), manufacturing based technologies (e.g. CNC machines, FMS, Robotics) and administrative technologies (e.g. EDI, MRP II and CIM). However the constructs differed in two respects. First, Dean and Snell's construct included a process/functional perspective as they also considered the degree to which transactions
between various processes were accomplished by computers. Second, Dean and Snell's work considered the extent to which a given firm had implemented a particular technology whereas in this research definitions include the extent of use and perception of its contribution to competitiveness. The implications of this definition are discussed further in Section 3.3.6.

Many different researchers have used different definitions for TQM and the reader is directed to Chapter 2, Section 2.9 for further discussion of typical definitions. We have chosen to adopt a definition aligned to the work of Snell and Dean (1991). In their work they indicate that TQM can be characterised by a few basic principles and practices that include: striving for continuous improvement, fulfilling customer needs, making quality a major responsibility of employees, ensuring that processes are capable of consistently high quality and adopting statistical control techniques. In this work, TQM is evaluated using a 9 point scale that includes, amongst other things, continuous improvement practices, knowledge of current and future customer requirements, processes for resolving customer complaints, employees attitude toward quality, methods to measure quality and adoption of statistical process control techniques. One question also evaluates the contribution of TQM to firm competitiveness.

Snell and Dean (1991), define JIT as a set of practices for reducing lead time and inventory. Key practices include: working closely with suppliers to simplify parts, working closely with supplier to increase the frequency of deliveries, reducing the time to perform activities with particular emphasis on machine set up time reduction, preventative maintenance and innovative materials and component handling systems. In this research JIT is evaluated using an 8 point scale. Measures include working with suppliers to improve processes, improving the quality of raw materials, the contribution of machine set up time to firm competitive position, the contribution of preventative maintenance to firm competitive position and the contribution of warehouse and materials management to firm competitive position. Two questions also directly assess the value of JIT to factory operations and competitiveness.

Similar to hard AMT, although not to the same extent, TQM and JIT constructs also include questions that reflect a hybrid of practice strength and perception of practice contribution to firm competitiveness.

3.3.4.1.2. Employee Performance

Employee performance has traditionally been measured in terms of productivity criteria and over the last two decades included quality perspectives. Recently there has been considerable interest placed in perspectives that reflect empowerment, involvement, cooperation and commitment (Australian Manufacturing Council, 1994A, 1994B, Ulrich 1991, Samson, 1991). The construct developed for employee performance in this research has been prepared from the analysis of various measures used by firms to assess changes in employee performance during periods of investment in technological, organisational and human resource
management areas. Employee performance is evaluated from 5 perspectives. The traditional areas of productivity, attitude toward customer service and morale have been buttressed with two additional perspectives: the level of industrial disputation and the strength of employee skills and abilities relative to competitors. The level of industrial disputation is considered to be a key, and reciprocal, measure of the degree of development of a cooperative work ethic between management and employees (Richards, 1993, Foster, 1994). The strength of employee skills and abilities relative to competitors is a measure of the degree to which human capital can add positive value to the firm.

3.3.4.1.3. Manufacturing Performance

The manufacturing literature is resplendent with various measures of performance. Measures for manufacturing performance tend to be catalogued in terms of business, operational and customer perspectives. Many researchers have made extensive use of business measures such as sales revenues, pretax profits, growth rate in sales, pretax return on assets and domestic and foreign market share (Roth and Miller, 1992, Dvir and Shenhar, 1992, Balan, 1995). As the unit of analysis for this research is a manufacturing site, an effort was made to adopt measures that primarily focus on operational performance rather than business performance where many other factors (eg. market trends, consumer preferences, competitor movements, corporate acquisitions and takeovers) may contaminate the results. Operational performance is typically measured in terms of the competitive priorities of cost, quality, delivery and flexibility (Balan, 1995). In this research the data was aggregated and not split by competitive priority and consequently care needed to be taken to ensure that operational measures used were relevant to all firm types. For example, a manufacturer of consumer electronics products may make extensive use of the measure: the ability to vary product mix, whilst an oil refinery involved in the manufacture of high volume, standardised commodity products will not use such a measure. The literature would also suggest that irrespective of competitive priority, firms place considerable emphasis on cost, quality and safety. These three perspectives were tested with a broad range of manufacturing executives and general agreement obtained that they represented key performance perspectives. A number of these executives indicated that the synergies associated with quality and cost (Crosby, 1979, Tribus, 1988, Samson, 1991) were also observed between safety and cost and safety and quality. In our case study research, Fibremakers also indicated that their entire performance culture was based on the principles of safety management providing further support to include safety as a core measure of manufacturing performance. In this research, Manufacturing Performance was assessed from these three perspectives using the five measures of cash flow, unit cost of production, customer satisfaction, "Deliveries In Full On Time" to customers and relative accident and injury frequency rate.
3.3.4.1.4. Practices

A number of practice instruments exist that have been developed principally in the field of TQM research (Saraph, Benson and Schroeder, 1989, Flynn, Schroeder and Sakakibara, 1994, Powell, 1995, Dow, Samson and Ford, 1996). However none of these were found to be suitable for this research which required scales that integrate various approaches to the development of practices in a form suitable for data analysis and that satisfy standards of academic rigour.

The work of Dow, Samson and Ford (1996), developed the instrument that is most relevant to this work and some aspects of their work were incorporated in this research. However, a number of key differences between these two areas of research need to be acknowledged and understood. It is also noteworthy that their work used a subset of the dataset used in this research. First, the objectives of their work were different. Dow et al were interested in assessing which organisational practices tend to coexist and the relationship of this practice set to quality performance. This work is primarily concerned with the relationship between aspects of integrated manufacturing and employee and manufacturing performance and organisational practices that support these relationships. Second, these different objectives translated into different methodologies and the use of different question sets. Dow et al make extensive use of Structural Equation Modelling, this research does not. This research makes extensive use of multiple regression and discriminant analysis, Dow et al’s work does not. Dow et al used a total of 47 questions. This work used a total of 72 questions with 29 of these common to Dow et al’s work. Third, different factors were formed in each area of research. As Dow et al’s study design did not seek to form a separate TQM construct, a number of TQM practices loaded on other practice constructs. For example, hybrid planning/customer focus and continuous improvement /workforce commitment constructs were developed in Dow et al’s work. It is also noteworthy that the data sets analysed were different in each body of work. Although the process used for imputing missing cells with the variable mean was the same for each study (refer section 3.3.4.2) the use of different question sets resulted in 591 cases being dropped for Dow et al’s work (698 usable responses) and 265 cases dropped for this research (1024 usable responses). The key similarity between the two bodies of work is that the team and training constructs are identical.

This study considered 7 key practices which were assessed using 33 questions. The selection of questions to form various constructs was guided by 3 key literature sources: manufacturing management, change management, organisational development. In particular extensive use was made of the Malcolm Baldridge Awards Criteria, the Deming Prize Criteria, Ernst and Young American Competitiveness Study, Australian Best Practice Demonstration Program Criteria, Made In Britain and the AMC Emerging Exporters Criteria in addition to the
insights gained from 12 detailed case studies performed on companies partaking in the Best Practice demonstration program. The seven practices considered (with the number of questions in each construct in brackets) are: leadership (4), Human Resource (HR) Management (5), planning (6), training (3), use of teams (4), ability to implement change (4) and benchmarking (7). Some of these practices: eg. training, teams and benchmarking have been considered by others (Cole, Bacdayan and White, 1993, Powell, 1995, Dow, Samson and Ford, 1996) and require little further explanation. Other practices, for example, leadership and planning, require clarification having been accorded different definitions in different works. Others, such as HR Management and the ability to implement change, although recognised as key organisational issues, have generally not been used in empirical work in the form presented in this research and require explanation.

As defined in this study, leadership measures both the presence of key individuals/managers who actively drive the change process and the ability of these individuals to create a high degree of unity of purpose throughout the site. It also includes a measure of the degree to which the organisation has created a work environment where production operatives actively contribute to improvement. Planning, as defined in this research incorporates a number key practices. The use of a mission statement that is supported by all employees and energised through a structured and comprehensive training process assesses aspects of strategic intent. Assessment of the involvement of key stakeholder groups in the planning process is essential to ensuring that the plan is needed, realistic and supported. The alignment of the manufacturing mission with the central business mission positions manufacturing to become a key driver of business success and is a key aspect of strategic planning (Hayes and Wheelwright, 1984, Hayes, Wheelwright and Clarke, 1988). Consequently, the construct also measures this perspective.

HR Management reflects a number of human resource management practices that have been associated with exemplar manufacturing operations. The particular perspectives assessed in this study are derived from the Malcolm Baldridge Award Criteria. (American Society for Quality Control, 1993). Key criteria addressed under Section 4, Human Resource Development and Management of the Malcolm Baldridge Award include, plans for the education and development of employees, integrating plans for employee development with business requirements, relating investments in human resources to improvements in manufacturing performance and adopting employee recognition and remuneration practices that support site performance. These perspectives are all addressed in the HR Management construct. The HR Management construct also addresses the additional perspective of the effectiveness of site communication processes.

The ability to implement change within an organisation, although perhaps more of a critical success factor than a practice, has been identified by many authors (Samson, 1991,
Ramsay, Samson and Sohal, 1991, Powell, 1995) as a key capability underpinning the success or failure of organisational improvement processes. The AMC (Australian Manufacturing Council, 1994) identified the ability to implement change as the single largest barrier to improvement in poor performing firms and indicated that better performing firms had substantially overcome this resistance. The AMC (Australian Manufacturing Council, 1990, 1992, 1994) also indicate that this resistance may be concentrated at the middle management or supervisory level rather exist "homogeneously" within the organisation. Other researchers (Beggs and Chapman, 1987, Business Council of Australia, 1989, Wooden and Sloan, 1990) have also indicated that external considerations such as union and employer body influences may impact on a firms ability to implement change. In this research, ability to implement change is assessed both internally and externally. The internal assessment is conducted at three different levels: senior management, supervisory and production operative. A further question addresses the impact of external barriers to employee relations improvement.

3.3.4.2 Data Preparation Stage 2 - Treatment Of Missing Data

This stage of data preparation is concerned with the treatment of incomplete responses. If remedies for missing data are not applied any observation with missing data on any of the variables will be excluded from the analysis (Hair, Anderson, Tatham and Black, 1995). Of the original 1289 responses, only 352 were complete. Consequently the researcher is faced with dropping almost three quarters of the responses or using some technique such as imputing the variable mean. The latter is only advisable when the proportion of blank cells is small (Bentler, 1993). For the purpose of this analysis a compromise approach was adopted. The 75 variables were divided into 12 constructs (3 - IM facets, 1- employee performance, 1 - manufacturing performance and 7 practices). If for any individual respondent : 1) more than one third of the variables assigned to a given construct were missing, or 2) there were more than 7 empty cells across all 72 variables for that respondent, then the entire response was deleted from the dataset. This approach yielded 1024 responses with only 0.04% of the total number of 73,728 cells, missing cells. With this sample set of 1024, the variable means were substituted for missing cells.

The 265 deleted cases were tested for response bias by comparing them with the retained dataset using MANOVA. Using exploratory factor analysis 12 key variables were identified and these variables plus indicators of firm size, firm type (ASIC/NZIC code) and ownership were used in the MANOVA. No significant difference was detected (F(12, 1004)) = 1.27, p = 0.278) between retained and deleted data sets. Amongst some of the key variables (TQM, JIT, hard AMT, leadership and ability to implement change) higher scores were detected for the 1024 usable responses than for the 265 deleted responses, but the difference did not reach the 0.05 level of significance.
3.3.4.3 Data Preparation Stage 3 - Data Checks

The third stage of data preparation is the screening for outliers and checking for normality (skew and kurtosis), multicollinearity and interval level measurement. Additional checks are also performed as required for each statistical techniques applied. This study makes extensive use of the technique of MULTIPLE REGRESSION and also uses MANOVA and DISCRIMINANT analysis in some areas of analysis. The use of MULTIPLE REGRESSION is a relatively robust procedure (Kerlinger and Pedhazur, 1973) but requires the following additional assumptions to be checked: homoscedasticity, additivity, measurement error, normality of the variate, independence of residuals and recursion. The development and use of cross products (violation of additivity) need also be considered. For MANOVA to be valid three assumptions must be met: independence, equality of the variance/covariance matrices and normality of any linear combination of dependent variables (Harris, 1975). The key assumptions in DISCRIMINANT analysis are multivariate normality of the independent variables and unknown (but equal) dispersion and covariance structures for the groups as defined by the dependent variable (Harris, 1975, Green, 1978).

We will now consider general data assumptions and then those relevant to each statistical technique applied.

3.3.4.3.1 Data Assumptions - General

Outliers: Four of the variables retained for analysis, are based on continuous scales. These four variables are: days of ongoing senior management training per year, days of ongoing middle management training per year, days of ongoing production operator training per year and number of full time employees in the year 1992-1993.

Tabachnik and Fidell (1989), describe outliers as “cases which have an unusual pattern of extreme scores” (p. 68). The process used to identify outliers was the CASEWISE subcommand in the SPSS REGRESSION procedure (SPSS Inc. 1993). The CASEWISE subcommand produces a plot of outliers that have standardised residuals larger than three (absolute value). The presence of such cases is an important consideration since they may unduly influence the results of statistical analysis. Consequently it is suggested that they be deleted prior to the analysis (Tabachnik and Fidell, 1989). For these three variables no standardised residuals greater than three were identified and therefore no outliers required deletion.

Normality: The four variables using continuous scales were all transformed using natural logarithms to correct for excessive skew and kurtosis. All other variables utilised interval scales and a total of 22 required transformation to correct for excessive skew and
kurtosis. These variables were: all 11 hard AMT variables and all 7 benchmarking variables (refer to Table 2.1), the proportion of production operators in cellular work teams, the proportion of production operators in problem solving teams, the proportion of production operators in quality circles and the degree of relative advantage in our people's skills and abilities. Prior to the development of factors further checks for normality were performed by preparing normal and detrended normal plots. The normal plots indicated that the observed values of each variable fell approximately on a straight line. The detrended normal plots indicated that the observed values of each variable were clustered around a horizontal line through zero. Further in each case the Liliefors significance level (Tabachnik and Fidell, 1989) for the Kolmogorov - Smirnov statistic exceeded 0.05.

**Multicollinearity**: Multicollinearity refers to the extent to which independent variables are highly correlated with one another. In particular, the multiple regression procedure assumes that no independent variable displays a perfect linear relationship to another independent variable in the equation (Berry and Feldman, 1985). Intercorrelations of less than 0.40 are considered desirable for multiple regression, while intercorrelations of greater than 0.80 are considered to be evidence of high multicollinearity (Asher, 1983, Berry and Feldman, 1985). Although multicollinearity does bias the estimates of the standard error of the coefficients, it does not bias the coefficients themselves. Such instability has little consequence for the prediction of different levels of the dependent variable, but has important consequences for the ability of the regression coefficients to accurately identify which independent variables have more important effects on the dependent variable.

The assumption of multicollinearity was first examined by comparing the bivariate correlations between all combinations of independent variables. This analysis indicated that the correlations between all combinations of the seven benchmarking questions are between 0.72 and 0.89. Those benchmarking practices with an intercorrelation exceeding 0.80 are:

- number of days per year invested reviewing other firms use of technology and number of days per year invested reviewing other firms product development processes (0.89)
- number of days per year invested reviewing other firms use of technology and number of days per year invested reviewing competitor's product range (0.85)
- number of days per year invested reviewing competitor's product range technology and number of days per year invested reviewing other firms product development processes (0.81)
- number of days per year invested reviewing other firms product quality procedures and number of days per year invested reviewing other firms customer service procedures (0.81)

No other correlation exceeds 0.80. Correlations less than 0.80 but exceeding 0.60 are:

- ability to implement change by senior management and ability to implement change by middle management (0.75)
• ability to implement change by middle management and ability to implement change by production operators (0.72)
• days training senior management and days training middle management (0.72)
• contribution of JIT to factory operations and contribution of JIT to competitiveness (0.69)
• operators involved in cellular work teams and operators involved in employee involvement groups (0.66)
• working with suppliers to improve processes and working with suppliers in process development (0.64)
• days training middle management and days training production operators (0.62)
• knowledge of customers requirements and dissemination of customer requirements to the workforce (0.60).

Of the remaining 2842 correlations considered, only 25 (less than 1%) were between 0.40 and 0.60. Of these, 12 were associated with variables within a common construct.

Due to the high level of association between the constructs of employee performance and manufacturing performance the correlations between the 10 practices that constitute these constructs were also examined for evidence of multicollinearity. The only correlation exceeding 0.80 was: we have a very high customer satisfaction and we deliver in full on time to our customers (0.81). Correlations between 0.60 and 0.80 were: we have a high employee morale and we have lower lost time due to industrial disputes (0.66), we have a high employee productivity and our unit cost of production is much lower than our competitors (0.63) and we have extremely positive cash flow and our total cost of product is much lower than competitors (0.60). Of the remaining 41 correlations only 3 exceeded 0.40.

**Interval Level Measurement:** The assumption of interval level measurement is that variables are measured in a continuous, rather than step-like manner. Because this work employs ordinal type scales to measure most variables, the assumption of interval level measurement is not satisfied. For example, consider the measurement of CAD. A response of 2 equates to no contribution and a response of 3 equates to a marginal contribution. However a response of 4 equates to a reasonably significant contribution. Consequently, the difference between 2 and 3 is different to that between 3 and 4 and the scale indicates relative value rather than absolute value. Never-the-less Tabachnick and Fidell (1989) argue that ordinal-type scales can be used in statistical analysis (notably regression) when the scales have several categories (5 in the present study) and measure quantifiable changes in the variables (true in the present study). Furthermore, research indicates that the techniques of MULTIPLE REGRESSION, MANOVA/MANCOVA and DISCRIMINANT are relatively insensitive to the use of ordinal rather than interval measures (Bohmstedt and Carter, 1971; Kim, 1975).
3.3.4.3.2 Data Assumptions - MULTIPLE REGRESSION

**Hoscedasticity** : The assumption of homoscedasticity is that the variance of the dependent variable is approximately the same at different levels of the independent variable (Hair, Anderson, Tatham and Black, 1995). According to Tabachnick and Fidell (1989), the relationship between the dependent variable and independent variables is homoscedastic when the variables are normally distributed. Homoscedasticity was examined by comparing the scatterplot of residuals obtained from the SPSS regression procedure. Homoscedasticity is indicated when the width of the band of residuals is approximately the same at different levels of the dependent variable; i.e. the shape of the scatterplot is approximately rectangular (Hair, Anderson, Tatham and Black, 1995). An examination of these plots for each dependent variable indicates that homoscedasticity is strongly supported for all 8 of the 10 variables (5 - employee performance and 5 - manufacturing performance). For the variables of industrial disputes and industrial accidents the residuals were somewhat skewed (the size of the residuals was smaller) at the low and high ends of the predicted values of the dependent variable. For these two cases the residuals were found to be within one standard deviation of the mean indicating that the violations of the assumption of homoscedasticity were minor.

**Additivity** : Additivity refers to the assumption that the amount of change in the dependent variable which is associated with a unit change in the independent variable is the same regardless of the value of the other independent variables. In other words, the effects of the independent variables of the dependent variable are additive rather than interactive (Berry and Feldman, 1985). Interactive effects result in a different sloped line representing the relationship between the dependent variable and a given independent variable for each level of a second independent variable (Cohen and Cohen, 1983). As this research evaluates a number of interactive effects associated with the integrated manufacturing construct (eg. TQM and JIT, TQM and hard AMT etc) the requirement for linearity is breached.

Cohen and Cohen (1975), have suggested that interactive effects can be catered for in multiple regression by the development and entry of cross product terms. In the development of the variate, the base effects (eg. TQM, JIT and hard AMT) are entered in the first step. In the second step, two way interaction effects of IM facets are entered (TQM * JIT, TQM * hard AMT and JIT * hard AMT) and in the third step three way interaction effects are entered (TQM * JIT * hard AMT). Significant incremental values of $R^2$ in the second and third steps can be interpreted as support for the presence of interactive effects. This approach to model the interactive effects of IM facets has also been used in the work of Snell and Dean (1991).
Linearity: The formulation of the regression equation reflects the assumption that the relationship between the dependent variable and the independent variables is linear. That is, the regression procedure assumes that the amount of change in the dependent variable which is associated with a unit change in the independent variable, is the same regardless of the value of the dependent variable and holding constant the effects of the other variables (Berry and Feldman, 1985). This linear relationship is graphically depicted as a straight line.

The breakdown of linearity was examined prior to the development of constructs using the SPSS MEAN (BREAKDOWN) procedure. The procedure tests for deviations from linearity for each pair of dependent and independent variables. Deviations from linearity at the 0.05 level of significance were found between:

- the dependent variable of employee morale and the independent variables of contribution of CAD, lasers and robots to our competitive position;
- the dependent variable of lost time due to industrial disputes and the independent variables of the contribution of CAD and robots to our competitive position, all employees believe that quality is their responsibility, champions of change are used to drive best practice and the contribution of cellular work teams to factory operations;
- the dependent variable of cash flow and the independent variables of contribution of CAD, CAM and robotics to our competitive position, all employees believe that quality is their responsibility, we proactively pursue continuous improvement, contribution of JIT to factory operations, days training for senior and middle management and proportion of production operators involved in quality circles and cellular work teams;
- the dependent variable of delivered in full on time to customers and the independent variables of contribution of CAM and lasers to our competitive position, we have an effective process for resolving customer complaints, knowledge of customers current and future requirements and external influences on industrial relations;
- the dependent variable of customer satisfaction and the independent variables of employees believe that quality is their responsibility and knowledge of customers future requirements.

To examine the seriousness of these deviations the researcher compared the residual plots obtained from the SPSS REGRESSION procedure. Examination of these plots did not reveal any serious or meaningful departures from linearity between the dependent and independent variables. Consequently, no further transformation of data was necessary.

Measurement Error: The reliability of measures is important because multiple regression assumes that all variables are measured without error (i.e. they have perfect reliability). In social sciences however, variables are seldom measured without error (Carmines and Zeller, 1979; Berry and Feldman, 1985). The consequence of error is that the variance of
the error term of the regression equation is increased. This has the effect of biasing the estimation of coefficients in the regression equation and is exacerbated by the magnitude of the correlations among the independent variables. The end result is that the explanatory power (i.e. $R^2$) of the equation is reduced (Berry and Feldman, 1985). The key issue affecting the reliability of measures is that all data from each survey came from one member of the Senior Management team familiar with the site’s operations. Whilst these individuals may be the “best respondent” under the circumstances, it would be preferable to have multiple respondents (e.g. production manager, quality manager, human resource manager, functional manager and representative section of employees) and more objective sources for the dependent variable (Dow, Samson and Ford, 1996). Multiple respondents would enable inter-rater reliability assessments to be undertaken to assess respondent reliability. In particular the effects of any response bias could be assessed. This could be of particular concern for questions concerning senior management behaviour and firm performance that have pejorative connotations.

Dean and Snell (1991), evaluated a number of aspects of Integrated Manufacturing using data from three different firm sources: plant managers, functional managers and non managerial employees. They found the inter-rater reliabilities (James, Demaree and Wolf, 1984) across these data sets to be extremely high, ranging from 0.79 to 0.96 and averaging 0.87. Due to these high correlations they formed a data set consisting of the average value of each variable which they subsequently used in their analysis. In a separate piece of work Snell and Dean, 1992, assessed a number of aspects of Integrated Manufacturing and various human resource management practices using data from managers and their subordinates. Again, they found high inter-rater reliabilities between datasets and consequently used the average value of each variable in their analysis. Balan (1995), also evaluated aspects of integrated manufacturing using three different datasets. In his work data was obtained from representatives, both managers and employees, of three different functions: operations, production control and quality. Balan did not analyse for convergence between datasets, but rather, conducted three separate analyses. Although some minor variation in results was noted (Balan, 1995, pp. 138 - 141) between population sets, the same conclusions were drawn irrespective of which data set was used. These findings lend substantial support for the approach taken in this research, suggesting that the results obtained are not substantially affected by the use of data derived from plant managers only.

Normality of the variate: The assumption of normality applies not only to dependent and independent variables but also to the relationship as a whole (Hair, Anderson, Tatham and Black 1995). The assumption of normality has importance for tests of statistical significance (particularly amongst small samples) but has no effect on the estimation of regression coefficients (Berry and Feldman, 1989). Moreover, Berry and Feldman (1985), and Bohrmstedt
and Carter (1971), argue that among larger samples, tests of statistical significance in multiple regression are quite robust to violations of normality.

The assumption of normality of the variate was examined by comparing the residual plots obtained from SPSS REGRESSION procedure. According to Tabachnick and Fidell (1989), the distribution of residuals should appear normal in shape. In the present study, an examination of residual plots for each independent variable indicated that the error terms are approximately normally distributed, supporting the assumption of normality.

Independency of Residuals: Independence of residuals refers to the assumption that the error terms (residuals) of the independent variables are uncorrelated (Berry and Feldman, 1985; Hair, Anderson, Tatham and Black, 1995). The correlation between error terms is alternatively referred to as autocorrelation (Tabachnick and Fidell, 1995). The problem of autocorrelation is a result of factors which have been omitted from the analysis and is most common when the observations of a single individual are collected at several points in time (Berry and Feldman, 1985). According to Berry and Feldman (1985), multiple regression is relatively robust to violations of the independence of residuals: although the estimation of regression coefficients is unaffected, the explanatory power of the model is attenuated somewhat. Because the problem of autocorrelation is difficult to test (Hair, Anderson, Tatham and Black, 1995), the estimates in this thesis are cross-sectional and the procedure is robust to autocorrelation, this study did not evaluate the independence of residuals.

Recursion: Recursion refers to the uni-directional flow of causality in the model tested (Kerlinger and Pedhazar, 1973). In other words, the regression equation assumes that the causal relationship between the independent variables and the dependent variables is one way, rather than reciprocal. An examination of the relationships considered in this research, for example, that investments in Integrated Manufacturing facets and Practices lead to improvements in performance, indicates that the assumption of recursion is consistent with the hypothesised causal relationships between variables.

3.3.4.3.3 MANOVA

For MANOVA to be valid three assumptions must be met: independence, equality of the variance/covariance matrices and normality of any linear combination of dependent variables (Harris, 1975).

Independence: Independence amongst observations can substantially effect the results of MANOVA (Hair, Anderson, Tatham and Black, 1995). The most widely used test to assess whether dependent measures are significantly correlated is Bartlett’s test for sphericity.
(Sheth, 1977). It examines the correlations amongst all dependent variables and assesses whether collectively, significant intercorrelation does exist. In all cases correlation amongst dependent variables was obtained below (and in most instances, very substantially below) the 0.05 level of significance.

**Equality of the Variance/Covariance Matrices**: Two levels of analysis were performed. The first analysis assessed the univariate homogeneity of variance across the groups using three tests: Cochran's C test, Bartlett - Box test and the Levene test. In no instances did the test statistic achieve significance at the 0.05 level of confidence and therefore the assumption of univariate homogeneity was not violated. The second analysis considered the equality of the variance/covariance matrix collectively using the Box's M test (refer DISCRIMINANT section below for further details).

**Multivariate Normality**: In the strictest sense this refers to the fact that the dependent variables are multivariate normal (Hair, Anderson, Tatham and Black, 1995). Simply put, this assumes that the joint effect of the two variables is normally distributed. There is no direct test for multivariate normality (Hair, Anderson, Tatham and Black, 1995) and therefore most analysts test for univariate normality of each variable only. Whilst univariate normality does not guarantee multivariate normality, if all variables meet this requirement, then any departures from multivariate normality are usually inconsequential (Berry and Feldman, 1985). Moreover any violations of this assumption have little impact when large sample sizes are used (Hair, Anderson, Tatham and Black, 1995). As plots of each dependent variable had been made, and any excessive departure from normality corrected by natural log transformation of the variable (and in addition the sample size was large) the assumption of multivariate normality was assumed.

3.3.4.3.4 Data Assumptions DISCRIMINANT Analysis

The key assumptions in DISCRIMINANT analysis are unknown (but equal) dispersion and covariance structures for the groups defined by the dependent variable and multivariate normality of the independent variables (Harris, 1975, Green, 1978).

**Equality of the Variance/Covariance Matrices**: Unequal covariance matrices can adversely affect the classification process (Hair et al, 1995). Where the groups are of sufficient sample size, this can result in observations being "overclassified" into the groups with the larger covariance matrices (Hair et al, 1995). The Box's M test assesses the similarity of the dispersion matrices for the independent variables between the groups. This test is highly sensitive to sample size and other characteristics of the independent variables eg. normality.
Test statistics obtained for this data were generally above the .05 significance threshold (in the Box M test values above the significance level indicate adequate similarity of dispersion matrices - Berry and Feldman, 1985). However, for a number of tests (eg. hard AMT and employee performance, hard AMT and manufacturing performance) the test statistic indicated significance at the 0.05 level of confidence. Whilst in many instances this significance level would indicate remedial action, the size of the sample population used (1024) makes it a very liberal test and consequently, it is judged to provide inadequate evidence that the dispersion matrices are sufficiently different to require corrective action (Hair et al, 1995).

*Multivariate Normality.* Refer to the multivariate normality section under MANOVA above.

### 3.3.5. Validity and Reliability Considerations

The approach taken to the analysis of the data commenced with the development of constructs and assessment of construct reliability and validity. In particular, the literature suggests considerable overlap in the construct domains for hard AMT, TQM and JIT implying that it is necessary to empirically confirm the dimensionality of the scales. Similar concerns needed to also be checked for the construct domains of leadership, HR Management, planning, training, teams, ability to implement change and benchmarking. It was also necessary to verify that the question sets developed for the constructs of employee and manufacturing performance did in fact load on a single construct.

#### 3.3.5.1 Validity: Construct Validity, Convergent Validity and Discriminant Validity.

There are three aspects of validity which concern this study. The first, construct validity, refers to the extent to which a theoretical relationship between constructs is supported by the empirical relationship between the measures used to operationalise constructs (Carmines and Zeller, 1979). Put differently, construct validity is concerned with the degree to which the measure accurately represents what it is supposed to (Hair, Anderson, Tatham and Black, 1995). A discussion of the measures used in this study was provided in Section 3.3.4.1 where it was indicated that measures adopted in this research have either been developed by other researchers, for example, the Integrated Manufacturing measures of Dean and Snell (1991), or adapted from leading edge documentation in this field (eg. Malcolm Baldridge Awards Criteria, the Deming Prize Criteria, Australian Quality Award Criteria etc). It is therefore assumed that the requirement for construct validity is satisfied. Convergent validity which refers to the extent to which multiple items measure the same construct and discriminant validity which measures the extent to which multiple items measure separate and distinct constructs (Campbell and Fiske, 1959). To support convergent and discriminant validity there
must be a greater level of association between the items which measure the same construct and a lower level of association between the items that measure related but different constructs.

Convergent and discriminant validity were assessed using exploratory factor analysis (Bohrnstedt, 1983; Campbell and Fiske, 1959). The aim of factor analysis is to reduce a large pool of items to a smaller set of factors (hypothesised constructs), Kim and Mueller (1978). Factor loadings are obtained for each item. These loadings reflect the strength of the relationship between an item and a particular factor (Tabachnick and Fidell, 1990). Factor loadings greater than 0.3 are evidence of convergent validity (Child, 1970). Discriminant validity, on the other hand, is evidenced by factor loadings that are less than 0.3 (Child, 1970). The FACTOR ANALYSIS procedure of SPSS was used to determine the factors (constructs) which underlie the initial pool of data. This procedure employs the maximum likelihood method of extraction and the orthogonal method of rotation, both of which are recommended by Kim and Mueller (1978) and Tabachnick and Fidell (1989). It is also recommended that oblique rotation be undertaken when the factors are assumed to be correlated with one another (Tabachnick and Fidell, 1989).

Separate factor analysis were undertaken for the IM facets (hard AMT, TQM, JIT), Organisational Practices, Employee Performance and Manufacturing Performance constructs. The factor loadings obtained for the multiple item measures are given in Table 3.1. Similar factor loadings were obtained using both orthogonal and oblique rotations. Items not complying with the requirements of convergent and discriminant validity are highlighted and have been deleted from the final scales. The final measure of each scale was constructed from the factor scores calculated and therefore IM facet and practice constructs exhibit the property of orthogonality. From Table 3.1 it can be seen that the data for all questions satisfied discriminant and convergent validity criteria except for:

- the factor “contribution of MRPII to our competitive position”, which loaded on both the hard AMT (0.306) and JIT (0.201) factors,
- the factor “our suppliers have an effective system for measuring the materials they send us” which loaded on both the JIT (0.367) and TQM (0.337) factors,
- the factor “our site has effective top down and bottom up communication processes” which loaded on both the leadership (0.297) and HR Management (0.499) factors

3.3.5.2 Factor Reliability

The second measurement issue, reliability, refers to the extent to which a measuring instrument or procedure yields the same result on repeated trials (Carmines and Ziller, 1978). In other words, a survey respondent should respond in a similar, consistent manner to multiple
measures of the same construct. The reliability of a measure decreases when random error is introduced to the measurement procedure through problems such as: ambiguously worded items, respondent fatigue and guessing (Berry and Feldman, 1985, Carmines and Zeller, 1978). The most commonly used measure of reliability is Cronbach's (1951) coefficient alpha. In this study the coefficient alpha (unstandardised) was obtained for each measure using the RELIABILITY procedure of SPSS.

According to Nunally (1978), in the latter stages of a research program it is considered desirable to have reliability coefficients of 0.80 or greater. In the early stages of a program, reliability coefficients should be at least 0.60 (Nunally, 1978). Reliability coefficients are also known to be affected by the number of items comprising the scale. (Cortina, 1993). For example, a three item scale displaying a reliability coefficient of 0.70 is considered more robust than a 10 item scale displaying similar reliability. Some authors have reduced acceptable thresholds of reliability when the measuring instrument consists of only a small number of variables. For example Jones and James (1979) claimed that an alpha value of 0.44 for a construct that consisted of only two variables is acceptable.

From examination of Table 3.1 it can be seen that the reliability coefficients of the measures all exceed the 0.60 threshold and are therefore acceptable for the purposes of this research with the (possible) exception of manufacturing performance which has a reliability coefficient of 0.592. As this item is only very marginally below the 0.60 threshold it has also been accepted. This is also supported by the work of Iverson and Kuruvilla (1996). They indicate that for modest reliabilities (< 0.7), the item-total correlations as well as the extent to which the scale is supported by factor analysis can also in assessing construct reliability. In the case of manufacturing performance, each scale item produced correlations in excess of 0.3 and the scale was supported by factor analysis as the eigen value, 1.32, exceeded the 1.0 threshold.

3.3.6 Limitations - Quantitative Research

A number of limitations associated with this research have already been indicated in the various sections but some general limitations need to be acknowledged. First a number of the scales evaluate both the presence of a particular attribute and the perception of its value. For example "please indicate whether CNC machines are used at your site and if so, the extent to which they have contributed to your competitive position." This concern is particularly germane to the hard AMT construct. Further, many of the variables in this construct exhibit relatively low variance. A considerable number of the responses are "clustered" around the "no contribution" category as many firms do not possess the respective advanced manufacturing technology. As will be shown in Chapter 4, the hard AMT construct fails to be statistically correlated with manufacturing performance construct. This implies that there are either
### Table 3.1 Questions Relating To Each Factor

**A. Integrated Manufacturing**

<table>
<thead>
<tr>
<th>Factor AMT</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Contribution of CAD and/or CAE to our competitive position</td>
<td>0.647</td>
<td>-0.042</td>
<td>0.077</td>
</tr>
<tr>
<td>2. Contribution of CAM to our competitive position</td>
<td>0.689</td>
<td>-0.027</td>
<td>0.074</td>
</tr>
<tr>
<td>3. Contribution of Computer Numerically Controlled Machines (CNC) to our</td>
<td>0.659</td>
<td>-0.022</td>
<td>0.112</td>
</tr>
<tr>
<td>competitive position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Contribution of Flexible Manufacturing Cells or Systems (FMS) to our</td>
<td>0.575</td>
<td>0.058</td>
<td>0.223</td>
</tr>
<tr>
<td>competitive position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Contribution of lasers to our competitive position</td>
<td>0.396</td>
<td>0.039</td>
<td>0.015</td>
</tr>
<tr>
<td>6. Contribution of Advanced Cutting Technologies to our competitive</td>
<td>0.499</td>
<td>0.008</td>
<td>0.073</td>
</tr>
<tr>
<td>position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Contribution of robots to our competitive position</td>
<td>0.396</td>
<td>0.034</td>
<td>0.035</td>
</tr>
<tr>
<td>8. Contribution of Automatic Storage and Retrieval to our competitive</td>
<td>0.374</td>
<td>0.021</td>
<td>0.005</td>
</tr>
<tr>
<td>position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Contribution of Local Area Network (LAN) for Technical Data to our</td>
<td>0.510</td>
<td>0.159</td>
<td>0.112</td>
</tr>
<tr>
<td>competitive position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Contribution of Electronic Data Interchange to our competitive position</td>
<td>0.474</td>
<td>0.136</td>
<td>-0.096</td>
</tr>
<tr>
<td>11. Contribution of Manufacturing Resource Planning (MRPII) to our</td>
<td>0.306</td>
<td>0.025</td>
<td>0.201</td>
</tr>
<tr>
<td>competitive position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Contribution of Computer Integrated Manufacturing (CIM) to our</td>
<td>0.496</td>
<td>0.112</td>
<td>0.101</td>
</tr>
<tr>
<td>competitive position</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Item 11. Deleted from the final scale

*Cronbach Alpha* 0.690
A2. Factor TQM

1. Contribution of TQM to our competitive position
   -0.018  0.581  0.273

2. All employees believe that quality is their responsibility
   0.089  0.606  0.039

3. We have well established methods to measure the quality of our goods and services
   0.062  0.582  -0.097

4. At this site we proactively pursue continuous improvement rather than reacting to crisis
   0.156  0.626  0.025

5. We know our external customers current and future requirements
   0.081  0.696  0.109

6. Customer requirements are disseminated/understood throughout the workforce
   0.042  0.642  0.062

7. We have an effective processes for resolving customer complaints
   0.086  0.607  0.087

8. Customer complaints are used to initiate process improvements
   0.021  0.597  0.077

Cronbach Alpha

0.742

A3. Factor JIT

1. Contribution of JIT to our competitive position
   0.133  -0.052  0.781

2. Contribution of JIT to factory operations
   0.217  0.033  0.764

3. Our suppliers have an effective system for measuring the quality of the materials they send us
   0.107  0.337  0.367

4. Our suppliers work closely with us to improve each others processes
   -0.039  0.314  0.659

5. Our order to delivery time is substantially less than our competitors
   0.112  0.267  0.621

6. Contribution of machine set up time to our competitive position
   -0.101  0.245  0.694

7. Contribution of warehouse and materials management to our competitive position
   0.073  0.106  0.463

8. Contribution of preventative maintenance to our competitive position
   0.105  0.121  0.438

Item 3 deleted from the final scale.

Cronbach Alpha

0.642
B. Performance

B1. Construct: Employee Performance
1. We have a high employee morale  
2. We have high employee productivity  
3. We have much lower lost time due to industrial disputes than our competitors  
4. We have an advantage in our employee’s skills and abilities  
5. The concept of the internal customer is well understood at this site  

Cronbach Alpha  

B2. Construct: Manufacturing Performance
1. We have very high customer satisfaction  
2. We have extremely positive cash flow (preinvestment)  
3. Our total cost per unit of product is much lower than our competitors  
4. We Deliver In Full On Time (DIFOT) to our customers  
5. We have much less lost time due to industrial accidents than our competitors  

Cronbach Alpha

Seven factors are considered:

C1. Leadership

1. Managers encourage change and implement a culture of trust, involvement and commitment
   - Cronbach Alpha

2. Champions of change are used to drive “best practice” at this site
   - Cronbach Alpha

3. There is a high degree of unity of purpose and we have eliminated barriers between dept’s
   - Cronbach Alpha

4. Ideas from production operators are actively used in assisting management
   - Cronbach Alpha

<table>
<thead>
<tr>
<th>Factor</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.142</td>
<td>0.304</td>
<td>0.703</td>
<td>0.064</td>
<td>0.102</td>
<td>0.007</td>
<td>0.011</td>
</tr>
<tr>
<td>2</td>
<td>0.164</td>
<td>0.241</td>
<td>0.639</td>
<td>0.014</td>
<td>0.143</td>
<td>0.020</td>
<td>0.012</td>
</tr>
<tr>
<td>3</td>
<td>-0.044</td>
<td>0.128</td>
<td>0.667</td>
<td>0.184</td>
<td>0.073</td>
<td>0.012</td>
<td>0.223</td>
</tr>
<tr>
<td>4</td>
<td>0.075</td>
<td>0.179</td>
<td>0.658</td>
<td>0.058</td>
<td>0.181</td>
<td>0.080</td>
<td>0.166</td>
</tr>
</tbody>
</table>

C2. HR Management

1. We have an organisation wide training and development process, including career planning
   - Cronbach Alpha

2. Our site has effective top down and bottom up communication processes
   - Cronbach Alpha

3. Employee multiskilling and training are actively used to support improved performance
   - Cronbach Alpha

4. We have a pay for performance scheme that contributes toward this sites performance
   - Cronbach Alpha

5. Our HR plan focuses on the skills/competencies required to manufacture products
   - Cronbach Alpha

<table>
<thead>
<tr>
<th>Factor</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.048</td>
<td>0.069</td>
<td>0.211</td>
<td>0.147</td>
<td>0.058</td>
<td>0.003</td>
<td>0.514</td>
</tr>
<tr>
<td>2</td>
<td>0.074</td>
<td>0.307</td>
<td>0.297</td>
<td>0.044</td>
<td>-0.003</td>
<td>0.072</td>
<td>0.499</td>
</tr>
<tr>
<td>3</td>
<td>0.012</td>
<td>0.212</td>
<td>0.243</td>
<td>0.100</td>
<td>0.066</td>
<td>0.136</td>
<td>0.578</td>
</tr>
<tr>
<td>4</td>
<td>0.056</td>
<td>0.054</td>
<td>-0.058</td>
<td>0.010</td>
<td>0.085</td>
<td>0.004</td>
<td>0.680</td>
</tr>
<tr>
<td>5</td>
<td>0.021</td>
<td>0.087</td>
<td>0.114</td>
<td>0.120</td>
<td>0.008</td>
<td>0.034</td>
<td>0.583</td>
</tr>
</tbody>
</table>

Item 2 deleted from the final scale

Cronbach Alpha

0.648
### C3. Planning

1. We have a mission statement supported throughout the organisation by all employees
   - Cronbach Alpha: 0.826
   - Internal consistency: 0.684
   - Item-total correlation: 0.129
   - Reliability: 0.162
   - Standard error: 0.069
   - Skewness: 0.125

2. We have a comprehensive/structured planning process that sets short and long term goals
   - Cronbach Alpha: 0.770
   - Internal consistency: 0.170
   - Item-total correlation: 0.025
   - Reliability: 0.067
   - Standard error: 0.021
   - Skewness: 0.049

3. Our plan focuses on the achievement of best practice
   - Cronbach Alpha: 0.666
   - Internal consistency: 0.320
   - Item-total correlation: -0.019
   - Reliability: 0.041
   - Standard error: 0.057
   - Skewness: -0.053

4. Our plans incorporate customers, suppliers and other stakeholders
   - Cronbach Alpha: 0.616
   - Internal consistency: 0.182
   - Item-total correlation: 0.077
   - Reliability: -0.008
   - Standard error: -0.001
   - Skewness: 0.107

5. We have a written strategy covering all operations that is agreed to by senior managers
   - Cronbach Alpha: 0.739
   - Internal consistency: 0.089
   - Item-total correlation: 0.006
   - Reliability: 0.156
   - Standard error: 0.072
   - Skewness: 0.060

6. Our sites manufacturing mission is aligned with our central manufacturing mission
   - Cronbach Alpha: 0.652
   - Internal consistency: 0.056
   - Item-total correlation: 0.115
   - Reliability: 0.110
   - Standard error: -0.006
   - Skewness: 0.144

### C4. Training

1. Days of ongoing senior management training per year
   - Cronbach Alpha: 0.903
   - Internal consistency: 0.088
   - Item-total correlation: 0.092
   - Reliability: 0.019
   - Standard error: 0.062
   - Skewness: 0.022

2. Days of ongoing middle management training per year
   - Cronbach Alpha: 0.691
   - Internal consistency: 0.038
   - Item-total correlation: 0.002
   - Reliability: 0.008
   - Standard error: 0.080
   - Skewness: 0.188

3. Days of ongoing production operator training per year
   - Cronbach Alpha: 0.823
   - Internal consistency: 0.070
   - Item-total correlation: 0.066
   - Reliability: -0.016
   - Standard error: 0.037
   - Skewness: -0.061

### C5. Teams

1. Proportion of production operators in quality circles
   - Cronbach Alpha: 0.773
   - Internal consistency: 0.181
   - Item-total correlation: 0.104
   - Reliability: 0.019
   - Standard error: 0.087
   - Skewness: -0.060

2. Proportion of production operators in cellular work teams
   - Cronbach Alpha: 0.785
   - Internal consistency: 0.091
   - Item-total correlation: 0.043
   - Reliability: 0.044
   - Standard error: 0.039
   - Skewness: 0.112

3. Proportion of production operators in problem solving teams
   - Cronbach Alpha: 0.790
   - Internal consistency: 0.106
   - Item-total correlation: 0.132
   - Reliability: -0.005
   - Standard error: 0.077
   - Skewness: 0.008

4. Contribution of cellular work teams to factory operations
   - Cronbach Alpha: 0.609
   - Internal consistency: 0.087
   - Item-total correlation: 0.178
   - Reliability: 0.006
   - Standard error: -0.007
   - Skewness: 0.214
C6. Ability To Change/Cultural Inertia

<table>
<thead>
<tr>
<th>Ability to implement change by senior management</th>
<th>Cronbach Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.017</td>
<td>0.836</td>
</tr>
<tr>
<td>Ability to implement change by middle management/supervisors</td>
<td>-0.010</td>
</tr>
<tr>
<td>Ability to implement change by production operators</td>
<td>-0.040</td>
</tr>
<tr>
<td>External influences on employee relations</td>
<td>0.001 -0.027</td>
</tr>
</tbody>
</table>

C7. Benchmarking

<table>
<thead>
<tr>
<th>Benchmarking</th>
<th>Cronbach Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of days per year reviewed other firms use of technology</td>
<td>0.917 0.132 0.070 -0.007 0.065 0.069 0.020</td>
</tr>
<tr>
<td>Number of days per year reviewed other firms HR practices</td>
<td>0.931 0.125 0.082 -0.005 0.092 0.063 0.016</td>
</tr>
<tr>
<td>Number of days per year reviewed other firms product quality procedures</td>
<td>0.892 0.119 0.075 -0.035 0.100 0.072 0.034</td>
</tr>
<tr>
<td>Number of days per year reviewed competitor’s product range</td>
<td>0.908 0.117 0.049 -0.013 0.063 0.042 0.056</td>
</tr>
<tr>
<td>Number of days per year reviewed other firms product development processes</td>
<td>0.902 0.107 0.066 -0.031 0.077 0.084 0.078</td>
</tr>
<tr>
<td>Number of days per year reviewed other firms safety records</td>
<td>0.911 0.121 0.070 0.004 0.083 0.067 0.060</td>
</tr>
<tr>
<td>Number of days per year reviewed other firms customer service procedures</td>
<td>0.898 0.107 0.056 0.009 0.092 0.081 0.062</td>
</tr>
</tbody>
</table>

Cronbach Alpha 0.747
problems associated with the construct and/or sample or, hard AMT is in fact not correlated with manufacturing performance and/or managers have a false sense of its value. These issues are discussed further in Chapter 6. The study also incorporates no longitudinal perspective and consequently, although causal relationships between IM investments and performance may be implied, they cannot be proven.

The research also does not consider the impact of competitive priority and business imperatives. For example, we have not considered whether firms that compete on the basis of quality have a greater association between TQM and performance than those competing on other performance criteria (eg. flexibility or cost). We have also not considered the impact of aspects of the business environment be they generic (eg. turbulent or static), or specific (eg. threat of closure, retrenchment, corporate acquisition etc) affect the relationship between constructs. We have however, controlled for the effects of company size, industry type (ASIC code) and duration of the change process. The only control variable demonstrating any significant affects was company size.

The scale for measurement of manufacturing performance is also marginal with respect to reliability criteria. There are also a number of possible limitations associated with the use of a single respondent which were discussed in Section 3.3.4.3.2 (Measurement Error).

3.4 Qualitative Analysis

3.4.1 Research Questions

Having used the quantitative analysis to assess associations between IM facet and practice investments and measures of performance, it is of considerable interest to both researchers and practitioners to gain insights into:

- **Implementation.** Firm’s approach to the implementation of TQM, JIT, AMT and practice investments,
- **Causality.** Do investments lead to superior performance outcomes or are firms demonstrating superior performance more predisposed to make IM facet and practice investments? and,
- **Value Adding Mechanisms.** Assuming that investments can, and do, lead to improvements in performance, the mechanisms by which this occurs.

Specifically the first dot point is concerned with an evaluation of the following core perspectives of the change process:

- the forces for change (factors determining the organisation’s need for change),
- the existing work environment (factors affecting the organisation’s ability to change),
- the planned change process and it’s relationship to the manufacturing strategic plan,
• the actual change process (what happened, why it happened, who was involved, how they became involved etc),
• the barriers to implementation and how they were addressed,
• key learnings.

The second and third dot points consider the relationships between investments in IM facets and practices and improved performance. In particular this areas of research is concerned with:
• the identification of the key performance categories and key capabilities that are critical to firm success,
• quantitative outcomes. The impact of these investments on key performance categories such as product quality, employee productivity, employee strength, cycle time and unit costs,
• qualitative outcomes. The impact of these investments on key organisational capabilities such as shared vision, shared values, distributed leadership and teamwork.

The quantitative analysis therefore seeks to identify the key managerial issues related to the adoption, implementation and evaluation of IM and practice investments. This area of research will also seek to develop further insights into a number of issues raised in the quantitative study, in particular the relationship between hard AMT and TQM, hard AMT and manufacturing performance, teams and manufacturing performance and benchmarking and manufacturing performance.

3.4.2 Participant Qualification/Selection and Sample Size Development

In order to be able to effectively address these perspectives, research sites need to exhibit the following criteria.
• A preparedness to grant access to personnel and documentation on issues that may be highly sensitive and involve confidentiality.
• A preparedness to grant access to a broad range of key personnel to capture the necessary depth of insight required.
• Involvement with significant investment in IM facets and practices.
• Investments in IM facets and practices have been completed or are nearing completion.
• Be representative of differing industry segments and competitive criteria.
• Be accessible for site visits.

These criteria were met by firms which were recipients of grants under the Australian Best Practice Demonstration Program (Australian Manufacturing Council Secretariat, 1994) during the period 1990 through 1994 as TQM, JIT and hard AMT were integral elements of many of the change processes adopted by these firms. The Best Practice Demonstration
Program was administered by the Department of Industrial Relations in association with the Australian Manufacturing Council secretariat. An overview of key details of the program is provided in Table 3.2. Essentially the program aimed at accelerating the introduction and dissemination of new workplace cultures based on international Best Practices through education, the injection of capital funding and the development of networks and alliances. In many instances investments in the program were accompanied with large investments in new technology. Firms participating in the program represented a broad range of business activities including manufacturing, finance, insurance and hospitality.

The issue of "how many" cases is clearly related to the generalisability of the findings obtained. Due to the exploratory nature of this research, the number of firms selected was not calculated using standard size formula. Moreover, no set of cases, no matter how large, is likely to be adequate, as case study findings should be generalised on analytical, rather than statistical, grounds (Yin, 1988, pp. 43). It was also not the objective of this study to provide statistical precision in testing propositions, but rather to derive a broad understanding of the key processes associated with the management and implementation of TQM, JIT, hard AMT and a number of specific practices.

During the period May 1994 - January 1995 detailed case studies were undertaken on 12 manufacturing firms who participated in this program. It was considered that a population of this size would provide a good balance between richness of findings and extent of effort. The 12 firms selected were Kellogg, Du Pont, Fibremakers, Edgell Birds Eye, Pampas, Australian Newsprint Mills, South Pacific Tyres, Dunlop Bedding, Murray Goulburn Co-operative, Tube Makers and Don Smallgoods. Key details of each firm and its Best Practice activities are provided in Chapter 5 (Table 5.1).

3.4.3 Case Research Process

The sponsorship of the Department of Industrial Relations (DIR) to perform the suite of 12 case studies greatly assisted in the research process. The DIR contacted all 12 companies, encouraged their strong and active participation in the process and introduced the researcher. All companies had a prior commercial obligation to participate in the case studies as this condition was stipulated in the conditions of contract associated with the awarding of the grant. The DIR had also undertaken a number of interim evaluations at most of the sites and established good relationships at Senior, Middle management and Shop Floor level. These relationships had generated a climate of trust, goodwill and openness and proved to be a key factor in the interview processes.

The DIR also issued a comprehensive case study protocol document to guide the interview process. This document was extremely comprehensive and considered not only aspects of the funded project but issues related to the overall company business environment
**INTRODUCTION**

The Australian Best Practice Program, announced in the March 1991 industry statement Building a Competitive Australia, aims to accelerate the introduction and dissemination of new ways of working, based on international best practice.

The program is funded by the Federal Government and administered by the Department of Industrial Relations in association with the Australian Manufacturing Council, with the involvement of the Department of Employment, Education and Training and the Development of Industry, Technology and Regional Development.

**PROGRAM OBJECTIVES**

The Best Practice Program aims to encourage Australian companies to adopt international best practice, identify effective methods and approaches for its implementation, and to promote a more widespread understanding of Best Practice in Australian companies in general.

The Program has two central components. It provides project assistance to specific companies and awards grants of up to half a million dollars to accelerate the introduction of their own change projects and their move towards international best practice. The purpose of providing program assistance has been to disseminate Best Practices widely throughout Australian industry by exposing companies to Best Practice role models.

**SELECTING THE COMPANIES**

Forty-three companies have been selected through two rounds of competitive bidding to receive funding to accelerate their change projects. Companies were invited by advertisements in the media to submit proposals for funding, outlining their change programs. These proposals were considered by an expert panel, made up of representatives from industry and trade unions, and projects were recommended to the Minister for Industrial Relations for approval.

Projects were selected on the basis of their potential to act as demonstration models for a wide cross-section of Australian industry. Other factors which were considered include: the spread of industries covered; the size of firms; and the overall geographic dispersion.

Each of the successful companies entered into a contractual agreement with the Commonwealth. Progress against workplans is evaluated regularly and grant instalments made accordingly.
and change strategy. The document was 22 pages in length and its scope incorporated the
issues addressed as part of this research.

The subsequent research process was split into 4 major steps

3.4.3.1 Step 1: Preparation

This step consisted of sourcing and analysing relevant company documentation, developing relationships with key company representatives and arranging interview schedules. Each firm had appointed a Best Practice co-ordinator at the commencement of the program who acted as the “on site” focal point.

3.4.3.2 Step 2 Interviews

Interviews typically involved 10 to 15 company representatives including, CEO, Employee Relations Manager, Best Practice Co-ordinator, line managers, supervisors and facilitators, team leader and team members (where appropriate), customer and supplier representatives, shop floor employees and union organisers. Many groups (union representatives and team leaders) were provided with briefing notes prior to the interviews. Interviews were conducted on site and typically lasted 30 - 40 minutes although a number exceeded 1 hour in duration. Site tours were also arranged. In many instances these served to assist the researcher gain a better understanding of new plant and technology investments. DIR representatives who had conducted site reviews and visits over the life of the project were also interviewed. Additional documentation and background material was also sourced during the interview process.

3.4.3.3 Step 3 Preparation of Draft Report

All interviews, notes and documentations were analysed and key learnings and outcomes identified. These learnings and outcomes served as a key checkpoint. They were confirmed with company and DIR representatives prior to the preparation of the draft report. Follow up interviews were also conducted as appropriate. Reports were prepared in a standard format which consisted of five key areas: company background information including the identification of the catalysts for change, a description of the overall change program and the Best Practice project, a discussion of the actual investments (TQM, JIT, hard AMT, benchmarking, HR reforms etc) made, a discussion of the outcomes achieved and an analysis of the key learnings. These reports therefore created a good basis from which to address the issues raised in this research.
3.4.3.4 Step 4 Final Report

This step consisted of issuing draft reports to company executives and DIR personnel for clearance and incorporating comments and amendments in the final report. In some instances considerable iteration was involved as local site issues and competitive considerations resulted in certain information being censored.

3.4.4 Limitations - Qualitative Research

A number of limitations are associated with the choice of sample and case study process adopted. First, the DIR bias needs to be acknowledged. In order to be awarded grants, firms had to prepare a detailed change strategy which was regularly reviewed during the life of the change process. This discipline forced many firms to develop a more comprehensive understanding of the change process before it was commenced than might have occurred otherwise and in addition, assisted in ensuring compliance with the program once it was commenced. A number of firms indicated they believed that "when the going got tough", and there was thought of abandoning aspects of the change process or reducing the level of investment in some areas, the contractual obligation with the DIR helped to ensure that this did not occur. The implication of the "DIR conscience" was that it helped to ensure that interventions such as TQM were effectively implemented. A further implication is that learnings were derived from "successful investments" as unsuccessful firms (that is those that had abandoned investments in JIT, TQM etc) did not form part of the sample population.

Second, the Australian Centre for Best Practice also developed a prescriptive change methodology which pervaded some organisations' thinking. Consequently the degree of variation in change strategy seen in this sample may be less than for the general population. As a number of organisations engaged representatives of the Centre For Best Practice to assist in the development and implementation of their change processes this had the impact of "standardising" the change strategy, the type of investments made and the relationship between the various investments. In a number of instances this impact had a negative impact as the standardised approach used was inappropriate for the circumstances that confronted the particular organisation. A third limitation was that a number of firms had only relatively recently made investments in technological, organisational and human resource areas and, to some extent, it was too early to assess their impact on performance. Although the timing of the studies satisfied the selection criteria (refer section 3.4.2), these criteria were based on completion of investments in IM facets and practices. In a number of instances further "lags" were observed between completing the implementation of the intervention and improvements in performance. Fourth, in assessing the value of soft and hard AMT investments, it is extremely difficult to decouple the influence of the actual investment on performance from the influence of the capability of those charged with implementing the investment on performance.
3.5 Chapter Summary

This chapter described the methods and processes used to test the propositions and address the questions posed in this research. The chapter commenced with a discussion of the use of quantitative and qualitative research methods to pursue the two complimentary areas of interest. The discussion indicated that quantitative methods were to be used to develop a set of generalisable conclusions about the relationship of TQM, JIT, hard AMT and various practices to performance. Qualitative methods were to be used to improve understanding of how firms select and implement these investments and how investments result in improvements in performance.

Aspects of the quantitative methodology were then discussed. The test instrument was indicated to be a 17 page mail survey of 4000 Australian and New Zealand Manufacturing firms. This instrument was shown to be built around a model of Best Practice consisting of the elements of strategy, practices and performance. The sample and respondent fatigue were also discussed. Data preparation was shown to consist of three distinct stages: selection of questions for inclusion in the study, treatment of missing responses and data checks. The questions used to measure the various constructs in this study were related to previous empirical research published in the academic press and Quality Award Criteria. The process used for the treatment of missing responses deleted 265 cases resulting in a final sample size of 1024 firms. Chi-squared tests were applied and found to support the representativeness of this final sample. Data checks performed in this analysis were also discussed. Outliers, normality (skew and kurtosis), multicollinearity, and interval level checks were discussed as well as the assumptions that accompany the use of the various statistical techniques used. For example, multiple regression checks included: homoscedasticity, additivity, linearity, measurement error, normality of the variate, independence of residuals and recursion. General support was found for all checks and assumptions. Construct, convergent and discriminant validity were then discussed. Three items failed to meet discriminant or convergent validity criteria and were deleted from the final scales. Scale reliability was then discussed. All measures used in this research were shown to satisfy established reliability criteria. Manufacturing performance was marginal (Cronbach alpha = 0.592) but acceptable, due to the “early stages of the program” (Nunally, 1978), the relatively small number of scale items used and the results of factor analysis which provided support for the scale. The section concluded with a discussion of study limitations.

The final section of the chapter considered qualitative analysis. This section opened with a description of the core emphasis of the work followed by a discussion of participant qualification and selection. Six key criteria for participant selection were identified which were met by recipients of grants under the Australian Best Practice Demonstration Program. The
section then briefly discussed the use of a sample size of 12 and provided an overview of the process used to prepare the case studies. This discussion indicated that the process used was particularly comprehensive developing insights into a broad range of areas through a structured set of interviews with a large number of employees. The discussion also indicated the rich sources of secondary information that were used in this study. The section, and chapter concluded with a discussion of some of the limitations of the qualitative study. These included DIR bias, exclusion of "unsuccessful" firms from the sample population, timing of the studies and decoupling the influence of the change champion from the content of the change program when evaluating its impact on performance.
CHAPTER 4.

RESULTS OF QUANTITATIVE ANALYSIS

4.1 Introduction

This chapter presents the methodologies applied and the results of the various tests used to assess propositions related to:

- the three Integrated Manufacturing facets: AMT (see note below), JIT and TQM.
- the seven practices of interest: ability to change, benchmarking, HR Management, leadership, planning, teams and training.

The particular set of perspectives of interest are articulated in the set of propositions detailed in Chapter 1 and summarised here in Table 4.1. These propositions have been grouped into four areas:

1. employee and manufacturing performance,
2. IM facets (hard AMT, JIT, TQM) and performance,
3. IM facets (hard AMT, JIT, TQM) and the seven practices,
4. IM facets (hard AMT, JIT, TQM), practices and performance.

After presenting and discussing a number of summary statistics (Section 4.2) and zero order correlations between variables (Section 4.3) the proposition sets in each of these four areas will be discussed in turn (Sections 4.4 through 4.7). Section 4.8 presents a summary of the key findings from the analysis. These findings are discussed in Chapter 6.

NOTE: The following key data assists in the interpretation of results:

- In this Chapter “hard AMT” (refer Chapter 1, Figure 1.1) is referred to as simply AMT,
- IM denotes Integrated Manufacturing,
- The construct, IM has been formed by loading TQM, JIT and AMT on a single factor,
- The construct Practices Net (Prac_Net) has been formed by loading all seven practices on a single factor,
- All results are controlled for any effects due to company size. Initially the variables: number of unions, ownership (public/private, independent/subsidiary), time of commencement of the change process and industry type (ASIC) were also used as control variables. These variables were subsequently dropped however, as they proved to have no statistically significant effect on any result,
- The sample size is 1024 in all tests and all reported p values are 2 tailed.
- In some areas of this research the results of a given analytical technique were found to be not in accordance with the predicted relationship. In some instances additional tests have been undertaken to enrich understanding of construct behaviour. This has only occurred where the additional insights are aligned with the broad research goals of this dissertation.
### Table 4.1

**Proposition Set**

1. **Propositions Related To Employee and Manufacturing Performance**
   
   **Proposition 1**
   
   Strong manufacturing performance is positively related to strong employee performance.

2. **Propositions Related To IM Facets (AMT, JIT, TQM) and Performance**
   
   **Proposition 2.1**
   
   Facets of IM (AMT, TQM, JIT) are positively related to employee performance. That is:
   - AMT is positively related to employee performance
   - JIT is positively related to employee performance
   - TQM is positively related to employee performance

   **Proposition 2.2**
   
   Facets of IM (AMT, TQM, JIT) are positively related to manufacturing performance. That is:
   - AMT is positively related to manufacturing performance
   - JIT is positively related to manufacturing performance
   - TQM is positively related to manufacturing performance

   **Proposition 2.3**
   
   The interactive effects of IM (AMT, TQM, JIT) are positively related to employee performance. That is:
   - AMT * JIT is positively related to employee performance
   - AMT * TQM is positively related to employee performance
   - JIT * TQM is positively related to employee performance
   - AMT * JIT * TQM is positively related to employee performance

   **Proposition 2.4**
   
   The interactive effects of IM (AMT, TQM, JIT) are positively related to manufacturing performance. That is:
   - AMT * JIT is positively related to manufacturing performance
   - AMT * TQM is positively related to manufacturing performance
   - JIT * TQM is positively related to manufacturing performance
   - AMT * JIT * TQM is positively related to manufacturing performance

   **Proposition 2.5**
   
   Firms weak in all facets of IM (AMT, TQM, JIT) exhibit weak employee performance.

   **Proposition 2.6**
   
   Firms weak in all facets of IM (AMT, TQM, JIT) exhibit weak manufacturing performance.
Proposition 2.7
Firms strong in all facets of IM (AMT, TQM, JIT) exhibit strong employee performance.

Proposition 2.8
Firms strong in all facets of IM (AMT, TQM, JIT) exhibit strong manufacturing performance.

Proposition 2.9
The stronger the IM facet (AMT, JIT, TQM) environment, the stronger the positive association between employee and manufacturing performance. That is:

- AMT is positively related to the strength of association between employee performance and manufacturing performance
- JIT is positively related to the strength of association between employee performance and manufacturing performance
- TQM is positively related to the strength of association between employee performance and manufacturing performance

Proposition 2.10
The stronger the employee performance environment, the stronger the association between facets of IM (AMT, TQM, JIT) and manufacturing performance. That is the stronger the employee performance environment:

- the stronger the association between AMT and manufacturing performance
- the stronger the association between JIT and manufacturing performance
- the stronger the association between TQM and manufacturing performance

3. Propositions Related to IM Facets and Practices

Proposition 3
Investments in IM facets (AMT, JIT, TQM) are positively associated with practice investments. That is:

- AMT is positively associated with practice investments
- JIT is positively associated with practice investments
- TQM is positively associated with practice investments

4. Propositions Related to IM Facets, Practices and Performance

Proposition 4.1
That (after the variance in employee performance due to IM facets has been considered) practices explain additional variance in employee performance.

Proposition 4.2
That (after the variance in employee performance due to IM facets has been considered) practices explain additional variance in manufacturing performance.
Proposition 4.3
Certain practice environments (eg. planning and leadership) are associated with stronger associations between IM facets (AMT, JIT, TQM) and employee performance.

Proposition 4.4
Certain practice environments (eg. planning and leadership) are associated with stronger associations between IM facets (AMT, JIT, TQM) and manufacturing performance.

Proposition 4.5
That the correlation between IM facets (AMT, JIT, TQM) and practices is strongest in environments with weak employee and strong manufacturing performance.

Proposition 4.6
That the correlation between IM facets (AMT, JIT, TQM) and practices is weakest in environments with strong employee and weak manufacturing performance.

Proposition 4.7
The strength of the manufacturing performance environment influences the strength of the associations between IM facet (AMT, JIT and TQM) and practice investments and employee performance.

Proposition 4.8
The strength of the employee performance environment influences the strength of the associations between IM facet (AMT, JIT and TQM) and practice investments and manufacturing performance.

Proposition 4.9
As the level of manufacturing performance increases, the strength of association between TQM and manufacturing performance decreases.

Proposition 4.10
The stronger the AMT environment, the stronger the practice environment.

Proposition 4.11
The stronger the AMT environment, the stronger the association between JIT and TQM and practice investments and employee performance.

Proposition 4.12
The stronger the AMT environment, the stronger the association between JIT and TQM and practice investments and manufacturing performance.
4.2 Summary Statistics

The description of results begins with a discussion of the summary statistics obtained from the dataset. Tables 4.2 lists the percentage of employees with factor scores of 1 to 5. Table 4.3 gives the means, standard deviations and minimums and maximums for each variable. Table 4.4 reports the scores for the 4 continuous variables used in this analysis. To simplify tabulation, decimal places have been omitted in all cases. Five different types of likert scales have been used in this research:

- **Type 1** (denoted T1) is a 5 point likert scale which uses the categorisations: 1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree) and 5 (strongly agree).
- **Type 2** (denoted T2) is a 5 point likert scale which uses the categorisations: 1 (much higher), 2 (higher), 3 (on par), 4 (lower) and 5 (much lower).
- **Type 3** (denoted T3) is a 5 point scale which uses the categorisations: 1 (negative contribution), 2 (no contribution), 3 (marginal contribution), 4 (reasonably significant contribution) and 5 (major contribution).
- **Type 4** (denoted T4) is a 5 point likert scale used only for benchmarking. It includes the categorisations 1 (none), 2 (less than 3 days/annum), 3 (between 3 and 5 days/annum), 4 (between 6 and 20 business days/annum) and 5 (more than 20 business days/annum).
- **Type 5** (denoted T5) are 5 point likert scales customised to that particular question. In this research, type 5 scales are used for the following questions:
  - **customer satisfaction**: 1 (sometimes meets expectations), 2 (generally meets expectations), 3 (consistently meets expectations), 4 (always meets expectations), 5 (customer expectations exceeded).
  - **employee morale**: 1 (very low), 2 (low), 3 (satisfactory), 4 (high), 5 (very high).
  - **productivity**: 1 (decreasing), 2 (static), 3 (moderate improvement), 4 (consistently improving), 5 (major and significant gains).
  - **cash flow**: 1 (negative), 2 (neutral), 3 (marginally positive), 4 (positive), 5 (extremely positive).
  - **delivered in full on time to our customers**: 1 (less than 50%), 2 (50 - 80%), 3 (81 - 90%), 4 (91 - 96%), 5 (97% - 100%).
  - **problem solving teams**: 1 (less than 5.0% of operators involved), 2 (5.0 - 9.9% of operators involved), 3 (10.0% to 19.9% of operators involved), 4 (20.0% - 50.0% of operators involved), 5 (more than 50% of operators involved).
  - **cellular work teams**: 1 (less than 5.0% of operators involved), 2 (5.0 - 9.9% of operators involved), 3 (10.0% to 19.9% of operators involved), 4 (20.0% - 50.0% of operators involved), 5 (more than 50% of operators involved).
### TABLE 4.2
Summary Statistics - Scale Responses (1/4)

<table>
<thead>
<tr>
<th>CONSTRUCT</th>
<th>QUESTION</th>
<th>SCALE** TYPE</th>
<th>1 (%)</th>
<th>2 (%)</th>
<th>3 (%)</th>
<th>4 (%)</th>
<th>5 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMT</td>
<td>Contribution of CAD/CAE</td>
<td>T3</td>
<td>1</td>
<td>42</td>
<td>20</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Contribution of CAM</td>
<td>T3</td>
<td>1</td>
<td>67</td>
<td>9</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Contribution of CNC</td>
<td>T3</td>
<td>0</td>
<td>62</td>
<td>10</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Contribution of FMS</td>
<td>T3</td>
<td>0</td>
<td>72</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Contribution of Lasers</td>
<td>T3</td>
<td>0</td>
<td>87</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Contribution of Cutting Tech</td>
<td>T3</td>
<td>1</td>
<td>84</td>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Contribution of Robotics</td>
<td>T3</td>
<td>1</td>
<td>84</td>
<td>6</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Contribution of Auto Storage</td>
<td>T3</td>
<td>1</td>
<td>94</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Contribution of LAN</td>
<td>T3</td>
<td>0</td>
<td>67</td>
<td>16</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Contribution of EDI</td>
<td>T3</td>
<td>1</td>
<td>64</td>
<td>16</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Contribution of CIM</td>
<td>T3</td>
<td>1</td>
<td>74</td>
<td>11</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>TQM</td>
<td>Contribution of TQM</td>
<td>T3</td>
<td>2</td>
<td>41</td>
<td>25</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Employees Responsible for Quality</td>
<td>T1</td>
<td>5</td>
<td>13</td>
<td>22</td>
<td>44</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Methods to Measure Quality</td>
<td>T1</td>
<td>1</td>
<td>7</td>
<td>17</td>
<td>56</td>
<td>19</td>
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<tr>
<td></td>
<td>Pursue Continuous Improvement</td>
<td>T1</td>
<td>2</td>
<td>18</td>
<td>21</td>
<td>45</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Know Customer Requirements</td>
<td>T1</td>
<td>2</td>
<td>13</td>
<td>19</td>
<td>53</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Disseminate Customer Needs</td>
<td>T1</td>
<td>2</td>
<td>20</td>
<td>29</td>
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**Notes:**

* To simplify tabulation, decimal places have been omitted.

The percentages may not always total 100% due to the rounding process.

In the case of missing variables imputed means have been rounded to the nearest category.

The results for training and firm size are reported in Table 4.4.

**Scales have been defined in Section 4.2.


## TABLE 4.2
Summary Statistics - Scale Responses (2/4)

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<tr>
<th>CONSTRUCT</th>
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<th>SCALE** TYPE</th>
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Notes:

* To simplify tabulation, decimal places have been omitted.
  The percentages may not always total 100% due to the rounding process.
  In the case of missing variables imputed means have been rounded to the nearest category.
  The results for training and firm size are reported in Table 4.4.

** Scales have been defined in Section 4.2.
### Summary Statistics - Scale Responses (3/4)

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**Notes:**

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In the case of missing variables imputed means have been rounded to the nearest category.

The results for training and firm size are reported in Table 4.4.

** Scales have been defined in Section 4.2.
## Table 4.2
Summary Statistics - Scale Responses (4/4)

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<td>Proportion of Operators in Problem Solving Teams</td>
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Notes:  
* To simplify tabulation, decimal places have been omitted.  
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The results for training and firm size are reported in Table 4.4.  
** Scales have been defined in Section 4.2.
<table>
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<th>CONSTRUCT</th>
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Note: * Means calculated from base data. Minor variations may occur if the data in Table 4.2 is used as a consequence of assigning imputed values to the closest category.
No data transformations have been performed.
TABLE 4.3  
Summary Statistics - Means, Standard Deviations, Minimums and Maximums (N=1024) (2/4)

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<td>2.62</td>
<td>0.900</td>
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<td>Cash Flow</td>
<td>3.58</td>
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<td></td>
<td>Total Unit Cost</td>
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<tr>
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<td>Deliver in Full on Time</td>
<td>3.52</td>
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<td>Accident Rate</td>
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<td>1.03</td>
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</table>

**Note:**  * Means calculated from base data. Minor variations may occur if the data in table 4.2 is used as a consequence of assigning imputed values to the closest category.
No data transformations have been performed.
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<tr>
<th>CONSTRUCT</th>
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<th>MEAN*</th>
<th>STD DEV</th>
<th>MIN</th>
<th>MAX</th>
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<tbody>
<tr>
<td>LEADERSHIP</td>
<td>Managers Encourage Change and Implement Culture of Trust and Involvement</td>
<td>3.37</td>
<td>1.08</td>
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<td></td>
<td>Champions of Change Drive Best Practice</td>
<td>3.59</td>
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<tr>
<td></td>
<td>High Degree of Unity of Purpose</td>
<td>3.26</td>
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<td></td>
<td>Ideas from Operators Actively Used</td>
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<td>1.00</td>
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<td>HR MANAGEMENT</td>
<td>Organisation Wide Training/Development Process</td>
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<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>Multiskilling/Training Actively used</td>
<td>3.84</td>
<td>0.82</td>
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<td>Pay for Performance Scheme that Contributes to Site Performance</td>
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<td>HR Plan Focuses on Skills/Competencies Required to Manufacture</td>
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<td>Plans Incorporate Customers/Other Stakeholders</td>
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<td>Manufacturing Mission Aligned with Central Business Mission</td>
<td>3.75</td>
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Note: * Means calculated from base data. Minor variations may occur if the data in table 4.2 is used as a consequence of assigning imputed values to the closest category. No data transformations have been performed.
# TABLE 4.3

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<th>MAX</th>
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</thead>
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<td>TEAMS</td>
<td>Proportion of Operators in Quality Circles</td>
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<td></td>
<td>Proportion of Operators in Cellular Work</td>
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<td></td>
<td>Teams</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proportion of Operators in Problem Solving</td>
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<td></td>
<td>Teams</td>
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<td></td>
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<td></td>
<td>Contribution of Cellular Work Teams</td>
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<td>1.11</td>
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<td>ABILITY TO</td>
<td>Ability to Implement Change - Senior</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ability to Implement Change - Middle</td>
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<td></td>
<td>Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Ability to Implement Change - Operators</td>
<td>3.08</td>
<td>1.06</td>
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<td>External Influences on Employee Relations</td>
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<td>Reviewing HR Practices</td>
<td>1.94</td>
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<td>Reviewing Product Quality Procedures</td>
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<tr>
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<td>1.00</td>
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<td>1.79</td>
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</tbody>
</table>

Note: * Means calculated from base data. Minor variations may occur if the data in table 4.2 is used as a consequence of assigning imputed values to the closest category.
No data transformations have been performed.
### Table 4.4

Summary Statistics - Continuous Variables

#### 1) Firm Size

<table>
<thead>
<tr>
<th>% CATEGORY*</th>
<th>MEAN SIZE</th>
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</thead>
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<tr>
<td>20-70 Employees</td>
<td>31</td>
</tr>
<tr>
<td>71-149 Employees</td>
<td>46</td>
</tr>
<tr>
<td>&gt;150 Employees</td>
<td>23</td>
</tr>
<tr>
<td>Number of Firms</td>
<td>93</td>
</tr>
</tbody>
</table>

#### 2) Training

<table>
<thead>
<tr>
<th>% CATEGORY*</th>
<th>MEAN SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5 Days/Year</td>
<td>31</td>
</tr>
<tr>
<td>5-10 Days/Year</td>
<td>44</td>
</tr>
<tr>
<td>&gt;10 Days/Year</td>
<td>25</td>
</tr>
<tr>
<td>Senior Management</td>
<td>6.2</td>
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<tr>
<td>Middle Management</td>
<td>6.9</td>
</tr>
<tr>
<td>Production Operators</td>
<td>7.9</td>
</tr>
</tbody>
</table>

*Continuous scores were recorded into three categorisations for the purposes of tabulation.*
• quality circles: 1 (less than 5.0% of operators involved), 2 (5.0 - 9.9% of operators involved), 3 (10.0% to 19.9% of operators involved), 4 (20.0% - 50.0% of operators involved), 5 (more than 50% of operators involved).

We will now briefly discuss this data commencing with AMT.

4.2.1 AMT

From Table 4.2 it can be seen that the technologies reported to make the greatest contribution to competitiveness, assessed in respect to the sum of responses for reasonably significant and major contributions, are: CAD/CAE (37%), FMS (28%), CAM (23%) and EDI (20%). Contrastingly, the technologies reported to make the least contribution to competitiveness, assessed in respect to the sum of responses for reasonably significant and major contributions, are: automatic storage and retrieval (4%), advanced cutting technologies (6%), lasers (9%) and robotics (10%). For each technology, with the one exception of CAD/CAE, in excess of 50% of the respondents indicate no contribution to competitiveness. Consequently mean values for all technologies were relatively low ranging from 2.07 to 3.08 (on a scale of 1 to 5) with the majority of values less than 2.80. As noted earlier, AMT questions used a hybrid scale measuring extent of use and perception of value. Consequently, high responses, for example, may reflect high levels of use and high contributions or low levels of use and high contributions. However, many firms provided zero responses indicating that AMT investments of the types assessed had not been made. These issues are discussed further in Chapter 6.

4.2.2 JIT

From a review of the data it can be seen that the responses of firms demonstrated considerable variation in opinion for this question set. For example 32% of respondents indicated that JIT made a reasonably significant or major contribution to competitiveness with 35% indicating that it made a significant contribution to factory operations. However over 43% of respondents indicated that JIT did not contribute to their competitiveness and consistent with this response, 37% indicated that it did not contribute to their factory operations. 43% of respondents also indicated that they "worked closely with suppliers to improve each others processes." 44% of respondents indicated that preventative maintenance made a significant contribution to their performance with 42% indicating that warehouse/materials management also made a significant contribution. However, the mean value of both practices was approximately 3.2 only (on a scale of 1 to 5) indicating that a significant number of respondents
held contrasting views. In 31% and 24% of cases respectively, respondents indicated that warehouse/materials management and preventative maintenance provided either a negative contribution or no contribution.

4.2.3 TQM

Nearly 80% of all respondents indicated that SPC made either a reasonably significant or major contribution to their competitiveness. 75% of respondents also indicated that they "used customer complaints to initiate improvements" and had "well established methods to measure the quality of their products and services." Of the nine questions that constituted this construct, seven had mean values above 3.5 (on a scale of 1 to 5). For the two questions "we disseminate customer requirements to the workforce" and "the contribution of TQM to our competitiveness" mean values were 3.34 and 2.94 (on a scale of 1 to 5) respectively. It is noteworthy that responses to the question "the contribution of TQM to our competitiveness", indicated that 43% of respondents believe TQM made either no contribution (41%) or a negative contribution (2%).

4.2.4 Employee Performance

Only 30% of respondents indicated that their workforce had a high morale with 50% indicating that "productivity was consistently improving". 60% of respondents also indicated that their "lost time due to industrial disputes" was lower than their competitors with only 8% indicating the converse. This question also had the highest mean value (3.80 on a scale of 1 to 5) of the five questions that constitute this construct. The lowest mean value (2.75 on a scale of 1 to 5) was associated with the question "we have an advantage in our people's skills and abilities". 46% of respondents disagreed with this statement with 25% indicating strong disagreement.

4.2.5 Manufacturing Performance

Only 12% of respondents indicated that "customer expectations were always met" with 42% indicating that they were either sometimes or generally met. 75% of respondents indicated that "cash flow was positive" with 12% indicating that it was "extremely positive". Only 12% indicated negative cash flow and this question had the highest mean value (3.58 on a scale of 1 to 5) of the 5 questions that form the construct. The lowest mean (2.62 on a scale of 1 to 5) was associated with the assessment of customer satisfaction. Only 31% of respondents indicated that their total cost per unit of production was lower than competitors with 43% also indicating that their accident rate was lower than competitors.
4.2.6 Ability to Change

There was a surprising degree of consistency amongst the four questions used to measure this construct. As expected, lower responses for middle management were noted, although not to the extent that is suggested in some areas of the literature. In respect to the ability of the various individuals and groups to implement change, 41% of respondents indicated that they possessed this capability at senior management level, 30% indicated they possessed it at middle management level and 39% indicated they possessed it at production operator level. Responses to the assessment of external influences on employee relations were mixed. 36% viewed these influences as positive with the same number of respondents viewing them as a negative.

4.2.7 Benchmarking

Inspection of Table 4.2 indicates that a significant number of firms do not perform the various types of benchmarking measured. Lower levels of benchmarking are associated with: product range (67%), product development process (63%), customer service procedures (60%) and HR practices (56). Conversely, higher levels of benchmarking are associated with “the use of technology” with only 37% of all firms not performing benchmarking in this area. Where benchmarking is performed frequency rates also appear to vary substantially. For example, in respect to “benchmarking the use of technology”, 12% of firms perform less than 3 days/annum, 16% between 3 and 5 days/annum, 23% between 6 and 20 business days/annum and 12% more than 20 business days/annum. However, in respect to “benchmarking of safety records”, 28% perform less than 3 days/annum, 12% between 3 and 5 days/annum, 8% between 6 and 20 business days/annum and 6% more than 20 business days/annum.

4.2.8 HR Management

74% of firms agreed that “employee multiskilling was actively used to support improved performance” but only 46% of firms reported having “organisation wide training and development processes”. However, the mean value of all four practices exceeded 3.0 (on a scale of 1 to 5) with means ranging from 3.24 to 3.84 indicating a reasonable degree of consensus amongst firms on the questions asked. 63% of respondents agreed that “pay for performance schemes contributed to their performance” with 25% of all respondents indicating strong agreement. 63% of respondents also indicated that their “HR plan focused on the skills and competencies required to manufacture products” with only a relatively small number (12%) disagreeing with this statement.
4.2.9 Leadership

Only 9% of all firms reported not "actively using ideas from production operators to assist production management". This question had the highest mean value (3.71 on a scale of 1 to 5) of the four questions forming the construct with 68% of respondents indicating that ideas from operators were actively used. Consistent with this response, 45% of respondents also indicated that they believed that "a high degree of unity of purpose" had been established between departments although it should be noted that a relatively high number of respondents (33%) neither agreed nor disagreed with this statement. 62% of respondents also agreed with the statement "we use champions of change to drive Best Practice" with a relatively small number of respondents (15%) disagreeing with this statement.

4.2.10 Planning

Responses indicated general agreement with all planning questions. Mean responses ranged from 3.50 to 3.84 (on a scale of 1 to 5). Almost 60% of all respondents agreed with each question, indicating a high degree of consistency of views (it is accepted that it is not necessarily the same set of respondents agreeing in each case). The area in which the greatest disagreement was noted related to the responses for the question "we have a written statement of strategy covering all manufacturing operations". 22% of all respondents disagreed with this statement. Conversely, only 10% of respondents disagreed with the statement "we have a comprehensive and structured training process which sets/reviews short and long term goals."

4.2.11 Teams

Responses indicated that many firms were yet to adopt team operating concepts to any degree. The mean values for this question set ranged from 2.02 to 2.89 (on a scale of 1 to 5). 70% of firms reported "less than 10% of all operators were involved in quality circles/employee involvement groups". 52% of firms reported "less than 10% of all operators were involved in problem solving teams". 66% of firms reported "less than 10% of all operators were involved in cellular work teams". Consistent with this response, 47% of firms also reported that cellular work teams made either a negative contribution or no contribution to their competitiveness.

4.2.12 Training

Table 4.4 summarises responses for the three training questions. The mean values for the number of days training undertaken per annum are 6.21: senior management, 6.94: middle management and 7.90: production operators. 32% of respondents indicated that, on average,
operator training commitments exceeded 10 days per annum. Only 25% of respondents indicated a similar level of training commitment for senior management.

4.2.13 Company Size.

Company size data is also reported in Table 4.4. The mean value of company size in the final sample (N = 1024) was 93 employees.

4.3 Results of Bivariate Analysis

The zero order correlations for AMT, JIT, TQM, all 7 practices, employee performance and manufacturing performance are given in Table 4.5. These correlations have been formed from the total dataset (N = 1024). We have organised our discussion of Table 4.5 into three areas: IM and performance, IM and practices and practices and performance.

4.3.1 IM and Performance

IM is moderately correlated with both employee performance (0.451, p < 0.001) and manufacturing performance (0.309, p < 0.001). These relationships also reflect the general, and expected, observation that IM, AMT, JIT and TQM are more strongly correlated with employee performance than manufacturing performance. TQM is the IM facet most strongly correlated with performance (employee performance = 0.496, p < 0.001; manufacturing performance, r = 0.399, p < 0.001). AMT and JIT correlations are relatively small. JIT correlations are: employee performance, r = 0.226, p < 0.001 and manufacturing performance: r = 0.135, p < 0.001. AMT has a small positive correlation with employee performance (r = 0.025, p = 0.006) and is not correlated with manufacturing performance at the p = 0.05 (or 0.10) confidence level. Due to the widespread associations between IM facets, practices, employee performance and manufacturing performance constructs, partial correlations were also examined. As expected, partial correlation co-efficients were generally somewhat smaller than the zero order correlation co-efficients although the differences were small. For example, controlling for the effects of all practices reduced the TQM - employee performance correlation coefficient from 0.496 to 0.487 and the TQM - manufacturing performance correlation coefficient from 0.399 to 0.390. JIT correlation coefficients were also reduced marginally. AMT also failed to be associated with manufacturing performance when the effects of all practices and employee performance were considered.

The finding that AMT is not correlated with manufacturing performance for the total dataset (when controlling for the effects of firm size and firm size and practices) creates a lens of enquiry that is further explored in the subsequent sections of the analysis.
4.3.2 IM and Practices

Table 4.4 also gives the correlations between IM, AMT, JIT, TQM, Prac_Net, and all seven practices (benchmarking, change, leadership, HR Management, planning, teams, training). Inspection shows:

- A very strong positive correlation (0.623) between Prac_Net and IM,
- At the .05 level of significance, all practices except the ability to change are correlated with the IM construct. The correlation co-efficients are: planning (0.359), leadership (0.339), benchmarking (0.289), HR Management (0.284), teams (0.207), and training (0.054).
- At the .05 level of significance, all practices are correlated with TQM. The correlation co-efficients are: planning (0.434), leadership (0.366), HR Management (0.274), benchmarking (0.120), training (0.107), teams (0.103), and ability to change (0.069). It is noteworthy that the highest correlation between IM facets and individual practices is between TQM and Planning. This is consistent with the emphasis placed both by practitioners and researchers on aligning the improvement efforts of employees with the strategic imperatives of the firm.
- At the .05 level of significance, all practices except the ability to change and training are correlated with JIT. The correlation co-efficients are: leadership (0.165), benchmarking (0.160), teams (0.153), HR Management (0.111) and planning (0.086).
- At the .05 level of significance, benchmarking, teams, HR Management and planning are correlated with AMT although in practical terms, the effects are extremely small. The correlation co-efficients are: benchmarking (0.229), teams (0.108), HR Management (0.089) and planning (0.064).

4.3.3 Practices and Performance

Inspection of Table 4.5 shows that Prac_Net has a weak to moderate correlation with both employee performance (0.430, p < 0.001) and manufacturing performance (0.237, p < 0.001) reflecting the general weak to moderate level of associations that exist between the various practices and measures of performance. These relationships also reflect the expected observation that practices are more strongly correlated with employee performance than manufacturing performance. Further examination of Table 4.5 shows:

- At the 0.05 level of significance, ability to change (0.145), HR Management (0.278), leadership (0.242), planning (0.175), training (0.106) are all correlated with manufacturing performance. Benchmarking and teams fail to achieve significance at the 0.05 (or 0.10) level of significance.
### TABLE 4.5
Correlation Matrix: IM Facets, Practices, Employee Performance and Manufacturing Performance

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<th>JIT</th>
<th>AMT</th>
<th>IM</th>
<th>BM</th>
<th>CHANGE</th>
<th>LEAD</th>
<th>HRM</th>
<th>PLAN</th>
<th>TEAM</th>
<th>TRAIN</th>
<th>PRAC-NET</th>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>- .366**</td>
<td>.242**</td>
<td>.394**</td>
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<td>- .218**</td>
<td>.278**</td>
<td>.398**</td>
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<td>-</td>
<td>-</td>
<td>- .484**</td>
<td>.175**</td>
<td>.275**</td>
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<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>- .278**</td>
<td>.045</td>
<td>.113**</td>
</tr>
<tr>
<td>TRAINING</td>
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<td></td>
<td></td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>- .188**</td>
<td>.106**</td>
<td>.103**</td>
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<td>All Practice Elements</td>
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<td></td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>- .237**</td>
<td>.430**</td>
<td></td>
</tr>
<tr>
<td>PRAC-NET</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
<td>-</td>
<td>-</td>
<td></td>
<td>.647**</td>
</tr>
</tbody>
</table>

** DENOTES SIGNIFICANT AT ≤ .05 (2 TAILED)
* DENOTES SIGNIFICANT AT ≤ .10 (2 TAILED)
DENOTES CORRELATION COEFFICIENT ≥ .40
At the 0.05 level of significance, ability to change (0.150), HR Management (0.398), leadership (0.394), planning (0.275), teams (0.113) and training (0.103) are all correlated with employee performance. Benchmarking fails to achieve significance at the 0.05 (or 0.10) level of significance.

TQM, Leadership, and HR Management are the three attributes with the greatest associations with employee and manufacturing performance.

Teams are correlated with employee but not manufacturing performance.

Benchmarking is weakly correlated with both JIT and AMT but the only practice not correlated (at 0.05 or 0.10 level of significance) with either employee performance or manufacturing performance.

Partial correlations (controlling for the effects of IM facets) were also considered for those practices that failed to achieve significance with employee or manufacturing performance constructs. These correlations also failed to achieve significance.

In summary, the principal observation from the correlation matrix is the general weak-to-moderate level of association between IM and practices, IM and performance and practices and performance. It is therefore particularly surprising that investments in AMT appear to have no direct relationship to manufacturing performance. In addition, many researchers and practitioners have argued the value of benchmarking and teams in respect to the development of improved workplace and manufacturing performance but the results of this analysis clearly do not support their claims. These issues will be explored further in the subsequent analysis.

4.4 Proposition Set 1. Employee and Manufacturing Performance

Proposition 1 was tested by direct inspection of the Table 4.5. The zero order correlation matrix indicates a moderate to strong association between employee and manufacturing performance (0.647, p < 0.0001) providing strong support for proposition 1. This would also suggest (causality cannot be proven) that improved employee performance is a very strong force in the progression of manufacturing firms toward world class standards of performance. We return to the relationship between employee and manufacturing performance later when we examine the impact of IM environment (Proposition 2.9).

4.5 Proposition Set 2. IM Facets (AMT, JIT, TQM) and Performance

4.5.1 Propositions 2.1 and 2.2

The statistical significance of AMT, JIT and TQM on the dependent variables of employee and manufacturing performance was tested using MANCOVA (controlling for the
The high correlation between employee and manufacturing performance provided support for the application of MANCOVA to assess the statistical significance of IM facets on the two areas of performance. Relationships were assessed using multivariate tests of significance (Pillais, Hottelings and Wilks) and standard univariate tests of significance. As expected, TQM and JIT passed all multivariate univariate tests of significance in all cases. AMT failed all multivariate tests and the univariate test of significance for manufacturing performance. AMT passed the univariate test of significance for employee performance but only at the 0.10 level of significance ($F = 2.79, \text{Sig} = 0.062$). Table 4.6 also shows the results of MULTIPLE REGRESSION for employee and manufacturing performance as a function of AMT, JIT and TQM. One way effects are entered at Step 2. The analysis was also repeated and the impact of the moderate to strong association between employee performance and manufacturing performance considered by controlling for the effects of the other performance variable. For example, for the REGRESSION equation where employee performance is the independent variable, manufacturing performance was entered as a control variable at Step 1. Beta values$^1$ changed only marginally from the non controlled case with AMT still failing to achieve significance for the dependent variable of manufacturing performance. Therefore proposition 2.1 is supported for all IM facets with proposition 2.2 supported for the IM facets of JIT and TQM only.

4.5.2 The Contribution of AMT

As we believe our manufacturing construct to be representative of actual manufacturing performance (reliability and validity criteria satisfied), our research need also address the issue of what “value” AMT actually adds, or put differently, under what conditions is AMT positively associated with manufacturing performance. We will briefly describe three areas of analysis that were performed. First, each IM facet was expressed as a categorical variable (weak average and strong) and two ANCOVA’s (controlling for the effects of company size) performed: one for employee performance and the other for manufacturing performance as a function of the three IM facets and evidence for interactions examined. The interactive effect AMT * TQM was found to be statistically significant in both cases. Subsequently three operating environments were formed: TQM weak, average and strong and ANCOVA’s for employee and manufacturing performance performed using JIT and AMT as the dependent variable. We find that AMT passes all multivariate tests of significance and univariate tests of significance for manufacturing performance ($F > 2.77, \text{sig} = 0.064$) for the TQM strong environment. The correlation coefficient is 0.1230, $p = 0.025$. AMT fails all univariate and

$^1$ Partial correlation coefficients were also calculated to assess the actual strength of association between each independent variable and the dependent variable. In all cases partial correlation coefficients differed only marginally from the Beta values reported.
### TABLE 4.6
**IM Facets, Cross Products, Employee Performance and Manufacturing Performance**
- Results of Multiple Regression Analysis

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>EMPLOYEE PERFORMANCE</th>
<th>MANUFACTURING PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BETA</td>
<td>ΔR^2</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>-.09</td>
<td>.007</td>
</tr>
<tr>
<td>Constant</td>
<td>.261</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMT</td>
<td>.071*</td>
<td>.309</td>
</tr>
<tr>
<td>JIT</td>
<td>.224**</td>
<td></td>
</tr>
<tr>
<td>TQM</td>
<td>.511**</td>
<td></td>
</tr>
<tr>
<td>CONSTANT</td>
<td>.506</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMTXJIT</td>
<td>.014</td>
<td>.001</td>
</tr>
<tr>
<td>AMTXTQM</td>
<td>.046*</td>
<td></td>
</tr>
<tr>
<td>TQMXJIT</td>
<td>-.026</td>
<td></td>
</tr>
<tr>
<td>CONSTANT</td>
<td>.478</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMTXJITxTQM</td>
<td>-.004</td>
<td>-</td>
</tr>
<tr>
<td>Constant</td>
<td>.478</td>
<td></td>
</tr>
</tbody>
</table>

** = p ≤ .05
* = p ≤ .10
Standardised Beta Values Reported
multivariate tests of significance in weak or average TQM environments. When we repeat the test for various JIT environments, AMT fails to be significant on all counts. *Hence AMT is positively and significantly correlated with manufacturing performance but only in a strong TQM environment.*

Second, we consider the impact of AMT environment on the associations of JIT and TQM with employee performance and manufacturing performance. Table 4.7 gives the results when manufacturing and employee performance are regressed against TQM and JIT in differing AMT environments (weak, average and strong). Inspection shows that the *stronger the AMT environment the stronger the explanatory power (adjusted $R^2$) of TQM and JIT on both manufacturing performance and employee performance.* That is, although AMT is not associated with manufacturing performance per se, it is positively associated with the strength of the associations between the other IM facets and manufacturing performance. We pursue this line of enquiry further in propositions 4.11 and 4.12 and in our qualitative analysis.

Third, we consider the mean value of IM facets as a function of manufacturing and employee performance. *From inspection of Table 4.8 it appears that firms with strong employee performance but weak manufacturing performance are strongest in AMT and firms with weak employee performance but strong manufacturing performance are weakest in AMT.* However, application of the Tukey test of difference between group means fails to achieve significance. Inspection of this table also shows a relatively small number of firms to be within these two performance categories, as expected, due to the relatively high level of association between employee performance and manufacturing performance.

### 4.5.3 Propositions 2.3 and 2.4

Two *MULTIPLE REGRESSION* analyses were then performed, one for each performance construct. Four step *MULTIPLE REGRESSION* was applied. At step 1 the control variable, firm size, was entered. AMT, JIT and TQM were entered at step 2, two way cross product terms (AMT * JIT, AMT * TQM and JIT * TQM) were entered at step 3 and the three way cross product term (AMT * JIT * TQM) was entered at step 4. A significant incremental difference in adjusted $R^2$ between steps 2 and 3 and 3 and 4 could be interpreted as support for propositions 2.3 and 2.4.

The results of regressing employee and manufacturing performance on the three IM facets and their interactions is reported in Table 4.6. From inspection of this table, the only interactive term that is significant is AMT * TQM, as expected. However the incremental change in adjusted $R^2$ is extremely small (0.001 for employee and 0.006 for manufacturing performance). The analysis was subsequently repeated with non-significant terms omitted. Variation in adjusted $R^2$ and Beta values was virtually insignificant. Hence there is only very
TABLE 4.7
JIT, TQM, Employee Performance and Manufacturing Performance - Results of Multiple Regression Analyses for Weak, Average and Strong AMT Environments

<table>
<thead>
<tr>
<th>AMT ENVIRONMENT</th>
<th>D.V = MANUFACTURING PERFORMANCE</th>
<th>D.V. = EMPLOYEE PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEAK</td>
<td>ADJ $R^2 = .167$ (F = 29.6)</td>
<td>ADJ $R^2 = .261$ (F = 38.2)</td>
</tr>
<tr>
<td></td>
<td>$TQM \div B = .330^{**}$</td>
<td>$TQM \div B = .464^{**}$</td>
</tr>
<tr>
<td></td>
<td>$JIT \div B = .148^{**}$</td>
<td>$JIT \div B = .250^{**}$</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>ADJ $R^2 = .212$ (F = 34.2)</td>
<td>ADJ $R^2 = .345$</td>
</tr>
<tr>
<td></td>
<td>$TQM \div B = .446^{**}$</td>
<td>$TQM \div B = .518^{**}$</td>
</tr>
<tr>
<td></td>
<td>$JIT \div B = .013^{**}$</td>
<td>$JIT \div B = .219^{**}$</td>
</tr>
<tr>
<td>STRONG</td>
<td>ADJ $R^2 = .257$ (F = 40.1)</td>
<td>ADJ $R^2 = .375$ (F = 51.3)</td>
</tr>
<tr>
<td></td>
<td>$TQM \div B = .473^{**}$</td>
<td>$TQM \div B = .570^{**}$</td>
</tr>
<tr>
<td></td>
<td>$JIT \div B = .196^{**}$</td>
<td>$JIT \div B = .241^{**}$</td>
</tr>
</tbody>
</table>

Effects of company size not shown as non significant in each instance.

B denotes standardised Beta Values
# TABLE 4.8

Mean value of IM Facets as a Function of Employee and Manufacturing Performance Environment

<table>
<thead>
<tr>
<th>Employee Perf.</th>
<th>Manufact. Perf.</th>
<th>Mean TQM</th>
<th>Mean JIT</th>
<th>Mean AMT</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>-.74</td>
<td>-.26</td>
<td>-.02</td>
<td>205</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>-.32</td>
<td>-.29</td>
<td>-.05</td>
<td>99</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>-.33</td>
<td>-.19</td>
<td>-.19</td>
<td>26</td>
</tr>
<tr>
<td>M</td>
<td>L</td>
<td>-.13</td>
<td>-.11</td>
<td>.08</td>
<td>95</td>
</tr>
<tr>
<td>M</td>
<td>M</td>
<td>.16</td>
<td>.05</td>
<td>-.13</td>
<td>126</td>
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<tr>
<td>M</td>
<td>H</td>
<td>.21</td>
<td>-.03</td>
<td>-.05</td>
<td>110</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>.26</td>
<td>.27</td>
<td>.36</td>
<td>42</td>
</tr>
<tr>
<td>H</td>
<td>M</td>
<td>.34</td>
<td>.48</td>
<td>.21</td>
<td>98</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>.60</td>
<td>.19</td>
<td>-.02</td>
<td>211</td>
</tr>
</tbody>
</table>

Note: Highest / lowest values of mean are shaded.

In summary, Table 4.8 shows:-

a) TQM to be the IM facet demonstrating the greatest change in mean value with changes in employee and manufacturing performance

b) Relatively few firms are in the H/L or L/H employee/manufacturing performance categories

c) Cases in b) relate to the lowest / highest mean values of AMT

d) The mean value of AMT to, in general, vary positively with increased strength of employee performance environment
weak support for propositions 2.3 and 2.4 and that support exists for only one (AMT * TQM) of the four interactive terms evaluated.

4.5.4 Propositions 2.5, 2.6, 2.7 and 2.8

Categorical variables for employee and manufacturing performance were then developed by inspection of population distributions and determination of 33% and 67% breakpoints to enable three levels of performance to be modelled: weak, average and strong. Employee performance means, manufacturing performance means and the correlation between employee and manufacturing performance constructs were then evaluated for each of the 27 IM facet environments. Tests of statistical significance for differences in the MEANS of employee and manufacturing performance between groups were then conducted by applying the Tukey-HSD test. Inspection of means and the determinations of statistical significance between means was then used to assess propositions 2.5 through 2.8.

Table 4.9 gives the results of this analysis showing the mean value of employee and manufacturing performance as a function of IM environment. 27 different environments are described (three variables each with three different states). Inspection of this table shows:

1. The lowest mean value of employee performance (-0.91) is found in environments weak in TQM and JIT and strong in AMT.
2. The highest mean value of employee performance (0.90) is found in environments that are strong in TQM, JIT and AMT.
3. The lowest mean value of manufacturing performance (-0.86) is found in environments weak in TQM and JIT and strong in AMT.
4. The highest mean value of manufacturing performance is found in environments that are strong in TQM and JIT and weak in AMT.

Investments in IM facets are expected to be positively associated with both employee and manufacturing performance (propositions 2.5 through 2.8). Consequently, the results 1., 3. and 4. above were examined further. Tukey's test of significance was initially applied to these three cases to test whether the difference between group means for each of the observed cases and the weakest, or strongest, as applicable, IM environment was statistically significant. For example, for case 1, Tukey's Test was applied to test whether the mean value of employee performance for the group that is weak in TQM, JIT and AMT is statistically different to the group that is weak in TQM and JIT but strong in AMT.

The results of these three Tukey tests indicate that:

- the difference in mean value of employee performance for environments weak in all three facets of IM to environments weak in TQM and JIT but strong in AMT was not statistically significant.
TABLE 4.9
Mean Values of Employee Performance and Manufacturing Performance as a Function of IM Facet Environment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>-.64</td>
<td>-.37</td>
<td>25</td>
<td>.57</td>
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<tr>
<td>L</td>
<td>L</td>
<td>M</td>
<td>-.89</td>
<td>-.62</td>
<td>46</td>
<td>.53</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>-.91</td>
<td>-.86</td>
<td>38</td>
<td>.61</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
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<td>-.70</td>
<td>-.38</td>
<td>34</td>
<td>.71</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>M</td>
<td>-.41</td>
<td>-.48</td>
<td>35</td>
<td>.61</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>H</td>
<td>-.73</td>
<td>-.52</td>
<td>31</td>
<td>.31</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>-.17</td>
<td>-.04</td>
<td>47</td>
<td>.62</td>
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<tr>
<td>L</td>
<td>H</td>
<td>M</td>
<td>-.41</td>
<td>-.48</td>
<td>35</td>
<td>.41</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>-.35</td>
<td>-.36</td>
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<tr>
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<td>.09</td>
<td>44</td>
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<td>H</td>
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<td>-.18</td>
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<tr>
<td>M</td>
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<td>.03</td>
<td>51</td>
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</tr>
<tr>
<td>M</td>
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<td>.08</td>
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<td>-.07</td>
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<td>H</td>
<td>L</td>
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<td>.61</td>
</tr>
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<td>H</td>
<td>M</td>
<td>.23</td>
<td>-.04</td>
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</tr>
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<td>.29</td>
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<td>H</td>
<td>.90</td>
<td>.60</td>
<td>44</td>
<td>.59</td>
</tr>
</tbody>
</table>

Note: Highest / lowest values of mean are shaded.

L = LOW
M = MEDIUM
H = HIGH
• the difference in mean value of manufacturing performance for environments strong in all three facets of IM to environments strong in TQM and JIT but weak in AMT was not statistically significant.
• the difference in mean value of manufacturing performance for environments weak in all three facets of IM to environments weak in TQM and JIT but strong in AMT was statistically significant.

Tukey’s test was also applied to case 2 (proposition 2.6). The mean value of employee performance for the case where all three IM facets are strong was found to be statistically different to:
• all cases in which TQM is low.
• all cases in which TQM is medium and JIT is low or medium.
• the case in which TQM is high and JIT and AMT are both low. It failed, however, to achieve significance for the other 7 cases where TQM is high.

Overall, these findings provide only partial support for propositions 2.5, 2.6 and 2.8. The findings also provide evidence to refute proposition 2.7.

4.5.5 Proposition 2.9
The statistical significance of IM facets (AMT, TQM and JIT) with respect to the strength of association between employee performance and manufacturing performance was then tested using ANCOVA (control for effects of company size). Identification of IM facets that achieve significance provides support for proposition 2.9.

Table 4.9 also gives the correlation between manufacturing and employee performance as a function of IM facets. An ANCOVA for this correlation coefficient as a function of the three IM facets shows AMT to be the only variable that is statistically significant (F = 4.21, signif < 0.026). Regressing this correlation against AMT shows the coefficient to be negative (beta = -0.35) with the adjusted $R^2 = 0.12$. Hence, the stronger the AMT environment, the weaker the correlation between employee and manufacturing performance. Hence proposition 2.9 is not supported.

4.5.6 Proposition 2.10
Variates representing the relationship between manufacturing performance and IM facets in weak, average and strong employee performance environments were prepared using MULTIPLE REGRESSION. The results of these runs were assessed qualitatively and differences interpreted as support for proposition 2.10.
Table 4.10 gives the results of these three analyses. The results of MULTIPLE REGRESSION were not significant for the environment of average employee performance. Furthermore, there is also little difference between the results for the environments of weak and strong employee performance. Consequently proposition 2.10 is not supported.

4.6 Proposition Set 3. IM Facets (AMT, JIT, TQM) and Practices

In section 4.3.2 we discussed the correlations between IM facets (AMT, TQM, JIT) and the seven key practices considered and found evidence of (general) weak to moderate associations (see Table 4.5). Four MULTIPLE REGRESSION analyses were then performed to evaluate interactions between each IM facet and the seven practices. One MULTIPLE REGRESSION equation was prepared for each of the dependent variables (IM, TQM, AMT, JIT). The seven practices constituted the independent variables. The results of these analyses were used to evaluate proposition 3.

The results of the analysis are shown in Table 4.11. As the practice constructs are orthogonally derived (factor analysis), the correlation coefficients representing the bivariate relationship between each practice and IM facet equate to the beta values given in the MULTIPLE REGRESSION equation. As expected, all four equations are significant at the .0001 level with overall F values ranging between 11.8 and 92.2. Practices were most strongly associated with IM (adjusted $R^2 = 0.47$), followed by TQM (adjusted $R^2 = 0.43$), then AMT (adjusted $R^2 = 0.15$) and finally JIT (adjusted $R^2 = 0.10$).

In summary, these results show that:

- All four equations are statistically significant indicating associations between investments in IM facets, collectively and individually, and investments in practices,
- TQM is the IM facet most strongly associated with investments in practices with planning, leadership and HR Management explaining the most variance in this construct,
- In all four equations, ability to change and training contribute relatively little, and in a number of instances, they fail to achieve statistical significance.

Consequently when these findings are combined with those of Section 4.3.2, there is substantial support for proposition 3. The proposition is most strongly supported for TQM and the aggregate IM construct (IM) with the practices of leadership, HR Management and planning explaining the most variance.
### TABLE 4.10
IM Facets and Manufacturing Performance - Results of Multiple Regression Analyses For Different Employee Performance Environments

<table>
<thead>
<tr>
<th>EMPLOYEE PERFORMANCE ENVIRONMENT</th>
<th>MANUFACTURING PERFORMANCE - MULTIPLE REGRESSION RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>W E A K</td>
<td></td>
</tr>
<tr>
<td>STEP 1 CONTROL</td>
<td>ADJ $R^2$ = .004</td>
</tr>
<tr>
<td>STEP 2 IM FACETS</td>
<td>ADJ $R^2$ = .077</td>
</tr>
<tr>
<td>STEP 3 2 WAY PRODUCTS</td>
<td>ADJ $R^2$ = .089</td>
</tr>
<tr>
<td>STEP 4 3 WAY PRODUCT</td>
<td>ADJ $R^2$ = .087</td>
</tr>
<tr>
<td></td>
<td>SIZE : $B$ = -.016</td>
</tr>
<tr>
<td></td>
<td>TQM: $B$ = .254**</td>
</tr>
<tr>
<td></td>
<td>AMT: $B$ = -.02 JI T: $B$ = .038</td>
</tr>
<tr>
<td></td>
<td>AMT x JI T: $B$ = .115**</td>
</tr>
<tr>
<td></td>
<td>AMT x TQM: $B$ = .093**</td>
</tr>
<tr>
<td></td>
<td>TQM x JI T: $B$ = -.06**</td>
</tr>
<tr>
<td></td>
<td>AMT x JI T x TQM: $B$ = .015</td>
</tr>
<tr>
<td>OVERALL $F$ = 4.18</td>
<td>SIGNIF $= .000$</td>
</tr>
<tr>
<td>A V E R A G E</td>
<td></td>
</tr>
<tr>
<td>STEP 1 CONTROL</td>
<td>ADJ $R^2$ = .001</td>
</tr>
<tr>
<td>STEP 2 IM FACETS</td>
<td>ADJ $R^2$ = .011</td>
</tr>
<tr>
<td>STEP 3 2 WAY PRODUCTS</td>
<td>ADJ $R^2$ = .002</td>
</tr>
<tr>
<td>STEP 4 3 WAY PRODUCT</td>
<td>ADJ $R^2$ = .0003</td>
</tr>
<tr>
<td></td>
<td>SIZE : $B$ = -.055</td>
</tr>
<tr>
<td></td>
<td>TQM: $B$ = .095*</td>
</tr>
<tr>
<td></td>
<td>AMT x JI T: $B$ = .003</td>
</tr>
<tr>
<td></td>
<td>AMT x TQM: $B$ = -.004 TQM x JI T $B$ = .03</td>
</tr>
<tr>
<td>OVERALL $F$ = 1.01</td>
<td>SIGNIF = .44 (NOT SIGNIF)</td>
</tr>
<tr>
<td>S T R O N G</td>
<td></td>
</tr>
<tr>
<td>STEP 1 CONTROL</td>
<td>ADJ $R^2$ = .029</td>
</tr>
<tr>
<td>STEP 2 IM FACETS</td>
<td>ADJ $R^2$ = .081</td>
</tr>
<tr>
<td>STEP 3 2 WAY PRODUCTS</td>
<td>ADJ $R^2$ = .079</td>
</tr>
<tr>
<td>STEP 4 3 WAY PRODUCT</td>
<td>ADJ $R^2$ = .079</td>
</tr>
<tr>
<td></td>
<td>SIZE : $B$ = -.127**</td>
</tr>
<tr>
<td></td>
<td>TQM: $B$ = .227**</td>
</tr>
<tr>
<td></td>
<td>AMT: $B$ = -.019 JI T: $B$ = .0007</td>
</tr>
<tr>
<td></td>
<td>AMT x JI T: $B$ = .29 AMT x TQM: $B$ = .026 TQM x JI T: $B$ = -.045</td>
</tr>
<tr>
<td></td>
<td>AMT x JI T x TQM: $B$ = -.039</td>
</tr>
<tr>
<td>OVERALL $F$ = 3.62</td>
<td>SIGNIF $= .000$</td>
</tr>
</tbody>
</table>

* SIGNIF $\leq .10$

** SIGNIF $\leq .05$

$B$ = STANDARDISED BETA VALUES
TABLE 4.11
Practices and IM Facets - Results of Multiple Regression Analyses

<table>
<thead>
<tr>
<th>DEP’D/T VAR’BLE</th>
<th>ADJ’ED R²</th>
<th>F</th>
<th>SIGNIF F</th>
<th>BM</th>
<th>CHANGE</th>
<th>LEAD</th>
<th>HRM</th>
<th>PLAN</th>
<th>TEAMS</th>
<th>TRAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>.47</td>
<td>92.16</td>
<td>.000</td>
<td>.26**</td>
<td>.04</td>
<td>.35**</td>
<td>.28**</td>
<td>.34**</td>
<td>.20**</td>
<td>.06*</td>
</tr>
<tr>
<td>TQM</td>
<td>.43</td>
<td>78.9</td>
<td>.000</td>
<td>.113**</td>
<td>.06**</td>
<td>.37**</td>
<td>.27**</td>
<td>.42**</td>
<td>.10**</td>
<td>.11**</td>
</tr>
<tr>
<td>JIT</td>
<td>.10</td>
<td>11.8</td>
<td>.000</td>
<td>.17**</td>
<td>.02</td>
<td>.16**</td>
<td>.11**</td>
<td>.10**</td>
<td>.16**</td>
<td>-.02</td>
</tr>
<tr>
<td>AMT</td>
<td>.15</td>
<td>18.9</td>
<td>.000</td>
<td>.17**</td>
<td>-.03</td>
<td>.06*</td>
<td>.09**</td>
<td>.03</td>
<td>.08**</td>
<td>-.00</td>
</tr>
</tbody>
</table>

* SIGNIF ≤ 0.10  
** SIGNIF ≤ 0.05

STANDARDISED BETA VALUES REPORTED
4.7 Proposition Set 4: IM Facets (AMT, JIT, TQM), Practices and Performance

4.7.1 Propositions 4.1 and 4.2

First, we return to the earlier MULTIPLE REGRESSIONS described in Table 4.6 and add the 7 practice variables as an additional step. A significant difference in adjusted \( R^2 \) between steps can be interpreted as support for propositions 4.1 and 4.2.

Table 4.12 shows the results of adding an additional step (step 5) to the MULTIPLE REGRESSION equations of Table 4.6. All 7 practices were loaded in this step. Incremental changes in adjusted \( R^2 \) can be interpreted as support for propositions 4.1 and 4.2. For employee performance, the addition of this step increases the adjusted \( R^2 \) value from 0.317 to 0.463, an increase of approximately 46%. The Beta values for all practices are positive and statistically significant with the exception of benchmarking (Beta = .002, F = 0.855). The test was repeated controlling for the effects of manufacturing performance. The changes in adjusted \( R^2 \) values from the uncontrolled case however, were small (0.463 to 0.458). Hence there is considerable support for proposition 4.1. For manufacturing performance, the addition of this step increases the adjusted \( R^2 \) value from 0.208 to 0.251, an increase of approximately 20%. The Beta values for all practices are positive and statistically significant with the exception of benchmarking (Beta = -.003, F = 0.955) and teams (Beta = 0.19, F = 0.529). The test was repeated controlling for the effects of employee performance. The changes in adjusted \( R^2 \) values from the uncontrolled case were also small (0.251 to 0.249). Hence there is considerable support for proposition 4.2.

In Table 4.13 we consider the relationship between performance and practice strength in more detail. The mean value of each practice is calculated as a function of the employee and manufacturing performance environment (refer to Table 4.8 for the mean value of IM facets as a function of employee and manufacturing performance environment). Key observations from this table include:

- the lowest mean for leadership occurs in the environment of low employee/high manufacturing performance
  (application of the Tukey test of significance between group means shows that the mean of this group is not significantly different to the group with low employee and low manufacturing performance)
- the lowest mean for benchmarking occurs in the environment of low employee/high manufacturing performance
  (application of Tukey test shows that the mean of this group is not significantly different to the group with low employee and low manufacturing performance).
TABLE 4.12
Adding Practices As An Additional Step To The Regression Equations Of Table 4.6 - Results of Multiple Regression Analyses

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>EMPLOYEE PERFORMANCE</th>
<th>MANUFACTURING PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BETA</td>
<td>ΔR²</td>
</tr>
<tr>
<td>STEP 5</td>
<td>.296**</td>
<td>.146</td>
</tr>
<tr>
<td>LEADERSHIP</td>
<td>.326**</td>
<td>.209</td>
</tr>
<tr>
<td>HR MANAGEMENT</td>
<td>.002</td>
<td>.081**</td>
</tr>
<tr>
<td>PLANNING</td>
<td>.002</td>
<td>.081**</td>
</tr>
<tr>
<td>TEAMS</td>
<td>.002</td>
<td>.081**</td>
</tr>
<tr>
<td>BENCHMARKING</td>
<td>.002</td>
<td>.081**</td>
</tr>
<tr>
<td>TRAINING</td>
<td>.002</td>
<td>.081**</td>
</tr>
<tr>
<td>CHANGE</td>
<td>.002</td>
<td>.081**</td>
</tr>
<tr>
<td>CONST.</td>
<td>.002</td>
<td>.081**</td>
</tr>
</tbody>
</table>

** P ≤ .05
* P ≤ .10

STANDARDISED BETA VALUES REPORTED
### TABLE 4.13

Practice Means and Aggregate Practice / IM Facet Associations As A Function Of Employee Performance and Manufacturing Performance Environments

<table>
<thead>
<tr>
<th>Employee Perform</th>
<th>Manuf. Perform</th>
<th>Mean Leadership</th>
<th>Mean HR Management</th>
<th>Mean Planning</th>
<th>Mean Change</th>
<th>Mean Teams</th>
<th>Mean Training</th>
<th>Mean Benchmarking</th>
<th>Number of Cases</th>
<th>Prac-Net IM Correlat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>-.47</td>
<td>-.45</td>
<td>-.43</td>
<td>-.19</td>
<td>-.16</td>
<td>-.17</td>
<td>.02</td>
<td>205</td>
<td>.57</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>-.33</td>
<td>-.46</td>
<td>-.40</td>
<td>-.12</td>
<td>-.09</td>
<td>-.18</td>
<td>.04</td>
<td>99</td>
<td>.49</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>-.67</td>
<td>-.01</td>
<td>-.38</td>
<td>-.10</td>
<td>-.12</td>
<td>.21</td>
<td>-.20</td>
<td>38</td>
<td>.73</td>
</tr>
<tr>
<td>M</td>
<td>L</td>
<td>.05</td>
<td>-.06</td>
<td>-.06</td>
<td>-.10</td>
<td>-.01</td>
<td>-.11</td>
<td>.00</td>
<td>95</td>
<td>.52</td>
</tr>
<tr>
<td>M</td>
<td>M</td>
<td>.01</td>
<td>-.07</td>
<td>.16</td>
<td>.06</td>
<td>-.09</td>
<td>.00</td>
<td>-.10</td>
<td>126</td>
<td>.49</td>
</tr>
<tr>
<td>M</td>
<td>H</td>
<td>.05</td>
<td>-.03</td>
<td>.04</td>
<td>.06</td>
<td>-.04</td>
<td>.21</td>
<td>-.12</td>
<td>110</td>
<td>.47</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>.34</td>
<td>.39</td>
<td>.01</td>
<td>.12</td>
<td>.30</td>
<td>-.07</td>
<td>.43</td>
<td>42</td>
<td>.41</td>
</tr>
<tr>
<td>H</td>
<td>M</td>
<td>.43</td>
<td>.36</td>
<td>.32</td>
<td>.10</td>
<td>.13</td>
<td>-.03</td>
<td>.15</td>
<td>98</td>
<td>.53</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>.44</td>
<td>.48</td>
<td>.32</td>
<td>.18</td>
<td>.09</td>
<td>.19</td>
<td>.02</td>
<td>211</td>
<td>.58</td>
</tr>
</tbody>
</table>

Notes:

a) Highest / lowest mean practice values and Prac Net / IM correlations shown shaded.

b) Strong employee / weak manufacturing environments make the highest use of teams.

c) Weakest correlation between Prac-Net and IM in environments with strong employee / weak manufacturing performance.

d) Strongest correlation between Prac-Net and IM in environments with weak employee / strong manufacturing performance.
• the highest mean for teams occurs in the environment of high employee/low manufacturing performance
  (application of Tukey test shows that the mean of this group is significantly different to the
  group with high employee and high manufacturing performance)
• the highest mean for benchmarking occurs in the environment of high employee/low manufacturing performance
  (application of Tukey test shows that the mean of this group is significantly different to the
  group with high employee and high manufacturing performance)

Hence we can conclude that firms with strong manufacturing and strong employee performance do less benchmarking and have fewer teams than firms with weak manufacturing and strong employee performance. This finding should be born in mind when considering the overall impact of practices on performance (i.e. propositions 4.1 and 4.2).

4.7.2 Propositions 4.3 and 4.4

Next, we develop correlation matrices for IM facets, IM net and employee and manufacturing performance as a function of various practice environments. We have previously identified practices that do, and do not explain additional variance in performance. We are now interested in determining the impact of various practice environments (eg. leadership strong, training weak etc) on the relationship between IM facets and performance. Seven categorical variables (weak, average and strong) were prepared, one for each particular practice from inspection of the distribution of each practice and determination of the 33% and 67% breakpoints. Fourteen correlation matrices were then prepared, two for each practice with weak and strong environments represented. Where the correlation between any IM facet and employee or manufacturing performance differed from the non-practice controlled environment by greater than 0.10², separate MULTIPLE REGRESSION was prepared to examine the overall effects of this environment on the MULTIPLE REGRESSION equations. From examination of the results, proposition 4.3 and 4.4 were assessed.

Table 4.14 shows the correlation between each IM facet and manufacturing and employee performance as a function of 15 different operating environments: one for the total population (no practice control) and two for each of the 7 practices (weak and strong environments represented). The cases in which a change in practice strength from weak to

² This analysis was repeated and cases selected on the basis of changes in R² rather than changes in R. This change in selection criteria resulted in some changes to those practices selected, particularly for practices demonstrating stronger levels of association with IM facets.
TABLE 4.14
Correlations Between IM Facets, Employee Performance and Manufacturing Performance As a Function of Practice Environment

<table>
<thead>
<tr>
<th>Employee Performance</th>
<th>Manufacturing Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEADERSHIP</strong></td>
<td><strong>HRM</strong></td>
</tr>
<tr>
<td>TQM</td>
<td></td>
</tr>
<tr>
<td>PRAC WEAK</td>
<td>.483**</td>
</tr>
<tr>
<td>PRAC STRONG</td>
<td>.190**</td>
</tr>
<tr>
<td>JIT</td>
<td>.172**</td>
</tr>
<tr>
<td>AMT</td>
<td>-0.011</td>
</tr>
<tr>
<td>PRAC WEAK</td>
<td>0.064</td>
</tr>
<tr>
<td>PRAC STRONG</td>
<td></td>
</tr>
</tbody>
</table>

** Denotes Signif at < .05
* Denotes Signif at < .10

Denotes change in correlations between weak and strong practice states of > .10
strong results in a change in the correlation between IM facets and performance by more than 0.10 are:

**Employee Performance Correlations**

- Benchmarking (correlation with TQM changes from 0.307 to 0.485),
- Benchmarking (correlation with JIT changes from 0.124 to 0.265),
- Teams (correlation with JIT changes from 0.106 to 0.269),
- Training (correlation with AMT changes from 0.019 to 0.117),
- Ability to change (correlation with JIT changes from 0.311 to 0.127),
- Ability to change (correlation with AMT changes from 0.117 to 0.131),

The means for each IM facet and employee performance were then calculated in these 8 different operating environments (weak and strong for the practices of benchmarking, teams, training and ability to change) and to assess the impact of these environments on the contribution of IM facets to employee performance, MULTIPLE REGRESSION was used. The results are given in Table 4.15.

**Manufacturing Performance Correlations**

- HR Management (correlation with JIT changes from 0.205 to 0.066),
- Planning (correlation with TQM changes from 0.330 to 0.432),
- Training (correlation with TQM changes from 0.320 to 0.426),
- Training (correlation with AMT changes from 0.033 to 0.106),

The means for each IM facet and manufacturing performance were then calculated in these 6 different operating environments (weak and strong for the practices of HR Management, planning and training). To assess the impact of these environments on the contribution of IM facets to manufacturing performance MULTIPLE REGRESSION was used. The results are given in Table 4.16.

Inspection of Tables 4.15 (employee performance) and 4.16 (manufacturing performance) shows that:

---

3 Fisher's Z test (Ferguson 1981) was used to test whether these differences in correlation coefficients were statistically significant. All tests performed achieved statistical significance.

4 Fisher's Z test (Ferguson 1981) was used to test whether these differences in correlation coefficients were statistically significant. All tests performed achieved statistical significance.
**TABLE 4.15**
IM Facets and Employee Performance - Results of Multiple Regression Analyses for Different Key Practice Environments

<table>
<thead>
<tr>
<th>DV = EMPLOYEE PERFORMANCE</th>
<th>BENCHMARKING</th>
<th>TRAINING</th>
<th>CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WEAK</td>
<td>STRONG</td>
<td>WEAK</td>
</tr>
<tr>
<td>MEANS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TQM</td>
<td>0.155</td>
<td>0.189</td>
<td>-0.151</td>
</tr>
<tr>
<td>JIT</td>
<td>-0.064</td>
<td>0.226</td>
<td>-0.142</td>
</tr>
<tr>
<td>AMT</td>
<td>-0.180</td>
<td>0.326</td>
<td>-0.041</td>
</tr>
<tr>
<td>EMPLOYEE PERF.</td>
<td>0.181</td>
<td>0.053</td>
<td>-0.081</td>
</tr>
<tr>
<td>STEP 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔR² / R²</td>
<td>.018/.018</td>
<td>0.06/0</td>
<td>0.006/0.006</td>
</tr>
<tr>
<td>SIZE</td>
<td>-1.43**</td>
<td>-0.53</td>
<td>-0.096*</td>
</tr>
<tr>
<td>F</td>
<td>6.99**</td>
<td>0.963</td>
<td>3.130*</td>
</tr>
<tr>
<td>STEP 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔR² / R²</td>
<td>0.113/0.131</td>
<td>0.310/0.310</td>
<td>0.224/0.230</td>
</tr>
<tr>
<td>AMT</td>
<td>0.075</td>
<td>0.065</td>
<td>0.023</td>
</tr>
<tr>
<td>JIT</td>
<td>0.175**</td>
<td>0.277**</td>
<td>0.406*</td>
</tr>
<tr>
<td>TQM</td>
<td>.329**</td>
<td>.495**</td>
<td>.470**</td>
</tr>
<tr>
<td>F</td>
<td>13.62**</td>
<td>38.55**</td>
<td>25.9**</td>
</tr>
<tr>
<td>STEP 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔR² / R²</td>
<td>0.007/.136</td>
<td>0.002/0.312</td>
<td>-0.001/-0.229</td>
</tr>
<tr>
<td>AMT x JIT</td>
<td>-0.003</td>
<td>-0.043</td>
<td>-0.019</td>
</tr>
<tr>
<td>AMT x TQM</td>
<td>0.119**</td>
<td>0.079</td>
<td>0.035</td>
</tr>
<tr>
<td>JIT x TQM</td>
<td>-0.026</td>
<td>-0.069</td>
<td>-0.033</td>
</tr>
<tr>
<td>F</td>
<td>8.68**</td>
<td>22.700**</td>
<td>15.18**</td>
</tr>
<tr>
<td>STEP 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔR² / R²</td>
<td>0.00/.136</td>
<td>-0.002/0.310</td>
<td>0.003/0.232</td>
</tr>
<tr>
<td>AMT x JIT x TQM</td>
<td>-0.056</td>
<td>-0.015</td>
<td>0.075</td>
</tr>
<tr>
<td>F</td>
<td>7.74**</td>
<td>19.81**</td>
<td>13.55**</td>
</tr>
</tbody>
</table>

** Denotes Signif at < .05
* Denotes Signif at < .10
<table>
<thead>
<tr>
<th>DV = MANUFACTURING PERFORMANCE</th>
<th>HRM</th>
<th>PLANNING</th>
<th>TRAINING</th>
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<tr>
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<tr>
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<tr>
<td>TQM</td>
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<tr>
<td>** Denotes Signif at &lt; .05</td>
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<tr>
<td>* Denotes Signif at = .10</td>
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**TABLE 4.16**

IM Facets and Manufacturing Performance - Results of Multiple Regression Analyses for different Key Practice Environments

<table>
<thead>
<tr>
<th>STEP 1</th>
<th>ΔR² / R²</th>
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<td>F</td>
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<td></td>
<td>9.36**</td>
<td>16.86**</td>
<td>14.89**</td>
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<td>STEP 2</td>
<td>ΔR² / R²</td>
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<tr>
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<td>ΔR² / R²</td>
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<td>F</td>
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<td></td>
<td>21.8**</td>
<td>25.5**</td>
<td>15.64**</td>
<td>28.60**</td>
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<td>STEP 3</td>
<td>ΔR² / R²</td>
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<tr>
<td></td>
<td>13.05**</td>
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<td>9.51**</td>
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<td>STEP 4</td>
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<tr>
<td></td>
<td>11.43**</td>
<td>13.66**</td>
<td>7.95**</td>
<td>15.88**</td>
<td>8.31**</td>
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</table>

**TABLE 4.16**

IM Facets and Manufacturing Performance - Results of Multiple Regression Analyses for different Key Practice Environments

** Denotes Signif at < .05
* Denotes Signif at = .10
Benchmarking Environment (Weak/Strong)
Means: From greatest to least variation: AMT (-0.180 to 0.326), JIT (-0.064 to 0.226), employee performance (0.181 to .053) and TQM (0.155 to 0.189).
MULTIPLE REGRESSION: Adjusted $R^2$ change: 0.138 to 0.310 (large increase)
Key Conclusion: The stronger the benchmarking environment, the greater the correlation between IM facets and employee performance and the weaker the employee performance.

Teams Environment (Weak/Strong)
Means: From greatest to least variation: JIT (-0.142 to 0.216), TQM (-0.151 to 0.143), AMT (-0.041 to 0.193), and employee performance (-0.081 to .148).
MULTIPLE REGRESSION: Adjusted $R^2$ change: 0.232 to 0.260 (small increase)
Key Conclusion: The stronger the team environment, the stronger the employee performance and stronger the IM environment.

Training Environment (Weak/Strong)
Means: From greatest to least variation: TQM (-0.061 to 0.164), JIT (0.093 to -0.014), AMT (-0.048 to 0.009), employee performance (0.058 to .099).
MULTIPLE REGRESSION: Adjusted $R^2$ change: 0.292 to 0.327 (small increase)
Key Conclusion: The training environment has little impact on the correlation between IM facets and employee performance, employee performance and IM facet strength.

Ability To Change Environment (Weak/Strong)
Means: From greatest to least variation: Employee Performance (-0.147 to 0.266), TQM (-0.019 to 0.186), JIT (-0.006 to 0.130), AMT (0.0433 to -0.044).
MULTIPLE REGRESSION: Adjusted $R^2$ change: 0.365 to 0.253 (moderate decrease)
Key Conclusion: The stronger the "ability to change" environment, the less the correlation between IM facets and employee performance and the greater the employee performance.

As a strong benchmarking environment enhances the relationship between IM facets and employee performance and a strong "ability to change" environment moderates the relationship between IM facets and employee performance, proposition 4.3 is supported.
HR Management Environment (Weak/Strong)
Means : From greatest to least variation : Manufacturing Performance (-0.419 to 0.445), TQM (-0.294 to 0.240), JIT (-0.082 to 0.129), AMT (-0.071 to 0.128).
MULTIPLE REGRESSION : Adjusted $R^2$ change : 0.199 to 0.236 (small increase)
Key Conclusion : The stronger the HRM environment, the stronger the manufacturing performance and the greater the level of investment in IM facets. HRM environment demonstrates a moderate association with manufacturing performance.

Planning Environment (Weak/Strong)
Means : From greatest to least variation : TQM (-0.524 to 0.472), Manufacturing Performance (-0.337 to 0.327), JIT (-0.153 to 0.113), AMT (-0.114 to 0.021).
MULTIPLE REGRESSION : Adjusted $R^2$ change : 0.144 to 0.261 (large increase)
Key Conclusion : The stronger the planning environment, the stronger the association between IM facets and manufacturing performance and the higher the level of manufacturing performance.

Training Environment (Weak/Strong)
Means : From greatest to least variation : TQM (-0.061 to 0.164), JIT (0.093 to -0.014), AMT (-0.048 to 0.009), manufacturing performance (0.059 to 0.101).
MULTIPLE REGRESSION : Adjusted $R^2$ change : 0.151 to 0.240
Key Conclusion : The stronger the training environment the stronger the association between IM facets and manufacturing performance.

As a strong planning environment or a strong training environment enhances the relationship between IM facets and employee performance, proposition 4.4 is supported.

4.7.3 Propositions 4.5 and 4.6
Next, the practice means for the 9 combinations of employee and manufacturing performance environment (each variable having been previously categorised as weak, average and strong) were prepared. The mean value of each practice and the overall practice mean were determined for each environment, the average value of IM elements for each environment having been determined in Step 2. The correlation between IM and Prac_Net was determined for each environment. From examination of these correlation coefficients, a preliminary assessment of proposition 4.5 and 4.6 may be made.

Examination of Table 4.13 shows the results of correlating IM with Prac_Net. This correlation can be interpreted as representing the degree of alignment between a firm's
collective investment in IM facets and collective investment in practices and consequently can be used to assess, at least to some degree, propositions 4.5 and 4.6. From inspection of this table it can be seen that the smallest correlation (0.41) occurs when employee performance is strong and manufacturing performance is weak with the largest correlation (0.73) occurring when employee performance is weak and manufacturing performance is strong. Application of Fisher’s Z test (Ferguson, 1981) of statistical significance shows the difference between these two correlation coefficients to be statistically significant. These findings provide some support for propositions 4.5 and 4.6.

4.7.4 Propositions 4.7 and 4.8

MULTIPLE REGRESSION was then undertaken for manufacturing (and employee performance) as a function of IM facets and practices for different strengths of employee (and manufacturing performance), respectively. That is, three different analyses were performed for manufacturing performance, one within each different employee performance environment (weak average, strong) and vice versa (total of 6 runs). Through examination of the results of these analyses propositions 4.7 and 4.8 were assessed.

Table 4.17 is a summary of the results of MULTIPLE REGRESSION analyses for manufacturing performance as a function of IM facets and practices for various (weak, average and strong) employee performance environments. Table 4.18 is a summary of the results of MULTIPLE REGRESSION analyses for employee performance as a function of IM facets and practices for various (weak, average and strong) manufacturing performance environments. Inspection of these tables shows that in both cases, performance environment has little impact on the overall correlation coefficient (adjusted $R^2$) or the relative contributions of the various independent variables. For manufacturing performance (Table 4.17), TQM is the dominant contributing element and the adjusted $R^2$ varies between 0.025 ($F = 1.77$, sig = 0.055) through 0.092 ($F = 4.15$, sig = .0001) dependent upon the strength of the employee performance environment. For employee performance (Table 4.18), leadership and HR Management, rather than TQM, are the dominant contributing elements and the adjusted $R^2$ varies between 0.336 ($F = 15.8$, sig = 0.001) and 0.376 ($F = 19.58$, sig = .0001) dependent upon the strength of the manufacturing performance environment. Consequently, there is little support for propositions 4.7 and 4.8. It is also worthy of note that with the exception of the weak manufacturing environment case, TQM is not a significant contributor to employee performance.

---

5 Partial correlation coefficients were also calculated to assess the actual strength of association between each independent variable and the dependent variable. In all cases partial correlation coefficients differed only marginally from the Beta values reported.
### Table 4.17
IM Facets, Practices and Manufacturing Performance - Results of Multiple Regression Analyses for Weak, Average and Strong Employee Performance Environments

<table>
<thead>
<tr>
<th>Employee Performance Environment</th>
<th>Weak</th>
<th>Average</th>
<th>Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>R=0.330  ADJ R^2 = 0.078</td>
<td>R=0.241</td>
<td>R=0.349</td>
<td></td>
</tr>
<tr>
<td>F= 3.58  SIGNIF = .001</td>
<td>F= 1.77</td>
<td>F= 4.15</td>
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<tr>
<td><strong>BETAS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TQM = 0.260**</td>
<td>TQM = 0.086**</td>
<td>TQM = 0.216**</td>
<td></td>
</tr>
<tr>
<td>HRM = 0.108**</td>
<td>JIT = 0.107*</td>
<td>CHANGE = 0.089*</td>
<td></td>
</tr>
<tr>
<td>CHANGE = 0.089*</td>
<td>LEADERSHIP = -0.133*</td>
<td>BENCHMARK = -0.106*</td>
<td></td>
</tr>
<tr>
<td>All Other Variables NOT SIGNIFICANT</td>
<td>All Other Variables NOT SIGNIFICANT</td>
<td>All Other Variables NOT SIGNIFICANT</td>
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</table>

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<tr>
<th>MANUFACTURING PERFORMANCE ENVIRONMENT</th>
<th>Weak</th>
<th>Average</th>
<th>Strong</th>
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<tr>
<td>R=0.629  ADJ R^2 = 0.376</td>
<td>R=0.610</td>
<td>R=0.589</td>
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</tr>
<tr>
<td>F= 19.58   SIGNIF = .0001</td>
<td>F= 16.6</td>
<td>F= 15.8</td>
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<tr>
<td><strong>BETAS</strong></td>
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</tr>
<tr>
<td>LEADERSHIP = 0.302**</td>
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<td>LEADERSHIP = 0.339**</td>
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<td>HRM = 0.321**</td>
<td>HRM = 0.337**</td>
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<td>TQM = 0.193**</td>
<td>PLAN = 0.200**</td>
<td>PLAN = 0.196**</td>
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<tr>
<td>PLAN = 0.194**</td>
<td>JIT = 0.146**</td>
<td>CHANGE = 0.167**</td>
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</tr>
<tr>
<td>CHANGE = 0.108**</td>
<td>TRAIN = 0.076*</td>
<td>TEAMS = 0.118**</td>
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</tr>
<tr>
<td>TEAM = 0.091**</td>
<td>CHANGE = 0.085**</td>
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</tr>
<tr>
<td>JIT = 0.086*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Other Variables NOT SIGNIFICANT</td>
<td>All Other Variables NOT SIGNIFICANT</td>
<td>All Other Variables NOT SIGNIFICANT</td>
<td></td>
</tr>
</tbody>
</table>

* SIGNIF ≤ .10
** SIGNIF ≤ .05

STANDARDISED BETAS REPORTED
4.7.5 Proposition 4.9

First, two correlation coefficients were calculated. The first, between TQM and manufacturing performance for a weak TQM environment. The second, between TQM and manufacturing performance for a strong TQM environment. In the weak TQM environment the correlation coefficient was 0.387 (adjusted $R^2 = 0.149$). In the strong TQM environment the correlation coefficient was 0.286 (adjusted $R^2 = 0.089$). Application of Fisher's Z test showed the difference between these two coefficients to be statistically significant. These findings lend support for proposition 4.9.

Two discriminant functions for manufacturing performance were also formed : one differentiating weak from average manufacturing performance and the other average from strong manufacturing performance. Discriminant functions were formed using IM facets and practices (10 variables). Examination of the relative predictive value (factor loading) of TQM in each equation was also used to assess proposition 4.9.

Table 4.19 presents the results of discriminant analyses for manufacturing performance. As can be seen from this table the canonical correlation coefficients for the two discriminant functions are similar. As structure loadings derived from discriminant analysis can be interpreted like factor loadings (Hair, Tatham, Anderson and Black, 1995, pp. 206), the square of the co-efficient represents the amount of variance explained by the given factor. Also, for the low/medium discriminant function, 73.2% of cases are correctly classified with 67.3% correctly classified for the medium/high discriminant function. Inspection of Table 4.19 shows that TQM has the strongest loading (0.670) of all factors in the low/medium case and the third highest loading (0.465) in the medium/high case. Consequently, TQM explains 45% of the variance (of the discriminant function) for the low/medium manufacturing performance case and only 22% of the variance for the medium/high manufacturing performance case. The finding that TQM explains approximately twice as much variance in manufacturing performance between low/medium performance groups than between medium/high performance groups also lends considerable support for proposition 4.9.

Note. In comparing the medium/high function to the low/medium function:

- **HR Management** changes from the highest loading factor to the fourth highest loading factor,
- **Leadership** has the second largest loading in both cases,
- **Benchmarking** changes from positive (0.145) and significant (0.10 level) to insignificant,
- **Teams** change from insignificant to positive (0.146) and significant (0.05 level),
- **Training** changes from insignificant to positive (0.196) and significant (0.05 level),
### TABLE 4.19
IM Facets, Practices and Manufacturing Performance: Results of Discriminant Analyses for Weak, Average and Strong Manufacturing Performance Environments

<table>
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<td>DISCRIM FUNCTION</td>
</tr>
<tr>
<td>AVERAGE / STRONG PERFORMANCE</td>
</tr>
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<td>CANONICAL CORRELATION</td>
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<td>STRUCTURE LOADINGS</td>
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<td>TQM = 0.670**</td>
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<td>TRAINING = 0.196**</td>
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<td>CHANGE = 0.153**</td>
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<td>TEAMS = 0.146**</td>
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<tr>
<td>BENCHMARK = 0.086</td>
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<tr>
<td>% CASES CORRECTLY CLASSIFIED: 73.2%</td>
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<tr>
<td>% CASES CORRECTLY CLASSIFIED: 67.3%</td>
</tr>
</tbody>
</table>

** SIGNIF ≤ .05
* SIGNIF ≤ .10

KEY DIFFERENCES

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177
Table 4.20 performs a similar analysis for employee performance. Canonical correlation coefficients are 0.621 for the low/medium discriminant function and 0.563 for the medium/high discriminant function. For the low/medium discriminant function 81.2% of cases are correctly classified with 72.3% correctly classified for the medium/high discriminant function. Inspection of Table 4.20 shows that TQM has the strongest loading (0.701) of all factors in the low/medium case and the second highest loading (0.492) in the medium/high case. Consequently, TQM explains 49% of the variance for the low/medium employee performance case and only 24% of the variance for the medium/high employee performance case. Therefore, the explanatory power of TQM is also approximately halved when comparing weak/medium to medium/strong employee performance environments.

Note. In comparing the medium/high function to the low/medium function:
- the top 3 factors are the same, only the order changes. Leadership and planning loadings do not change appreciably
- teams change from being positive and significant (0.406) to insignificant (0.010)
- HR Management changes from being positive and significant (0.283) to insignificant (0.011)
- JIT changes from being insignificant (0.101) to positive and significant (0.267)

Correlation coefficients between TQM and employee performance were also calculated in weak and strong TQM environments. In a weak TQM environment the correlation coefficient was 0.460 (adjusted $R^2 = 0.212$). In the strong TQM environment the correlation coefficient was 0.352 (adjusted $R^2 = 0.136$). Application of Fisher’s Z test showed the difference between these two coefficients to be statistically significant.

4.7.6 Proposition 4.10

Practice means were assessed for the three AMT environments of weak, average and strong. A DISCRIMINANT function for AMT as a function of practices was also performed. These results were examined for support for proposition 4.10.

Table 4.21 gives the mean value of each practice, (TQM and JIT also included) for the AMT environments of weak, average and strong. Inspection of this data shows:
- benchmarking to be the variable exhibiting the greatest variation in mean value : -0.224 (AMT weak) to 0.337 (AMT strong).
- HR Management mean varies from -0.035 (AMT weak) to 0.145 (AMT strong).
- TQM mean varies from -0.118 (AMT average) to 0.130 (AMT strong).
### Table 4.20
IM Facets, Practices and Employee Performance: Results of Discriminant Analyses for Weak, Average and Strong Employee Performance Environments

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<td>AVERAGE / STRONG</td>
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<td>CHI SQUARE</td>
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<td></td>
</tr>
<tr>
<td>LEADERSHIP</td>
<td>0.513**</td>
<td>TQM = 0.492*</td>
</tr>
<tr>
<td>PLANNING</td>
<td>0.382**</td>
<td>PLANNING = 0.408</td>
</tr>
<tr>
<td>JIT</td>
<td>0.267**</td>
<td></td>
</tr>
<tr>
<td>CHANGE</td>
<td>0.172**</td>
<td></td>
</tr>
<tr>
<td>TRAINING</td>
<td>0.153**</td>
<td></td>
</tr>
<tr>
<td>HRM</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>TEAMS</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>AMT</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>BENCHMARK</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>% CASES CORRECTLY</td>
<td>81.2%</td>
<td></td>
</tr>
<tr>
<td>% CASES CORRECTLY</td>
<td></td>
<td>72.3%</td>
</tr>
</tbody>
</table>

** SIGNIF ≤ .05  
* SIGNIF ≤ .10

KEY DIFFERENCES  
Highlighted
### TABLE 4.21

JIT, TQM, Practice, Employee Performance and Manufacturing Performance Means As A Function of AMT Environment

<table>
<thead>
<tr>
<th>AMT Environment</th>
<th>ATTRIBUTE MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LEADERSHIP</td>
</tr>
<tr>
<td>WEAK</td>
<td>.037</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>.020</td>
</tr>
<tr>
<td>STRONG</td>
<td>-.046</td>
</tr>
</tbody>
</table>
- Team mean varies from -0.100 (AMT weak) through 0.111 (AMT strong).
- JIT mean varies from -0.124 (AMT average) to 0.129 (AMT strong).

Table 4.22 gives the results of a DISCRIMINANT analysis for AMT as a function of the 7 practice constructs. Canonical correlations and discriminant loadings are also provided. The results of this analysis show that benchmarking, HR Management, and Teams reach significance in the major discriminating function. Leadership is also significant but in the minor function only. The percentage of cases classified correctly using these discriminating functions is 47.6% (chance criterion 33.3%). Consequently there is some support for proposition 4.10 but only for benchmarking, HR Management, teams and leadership. Ability to change, planning and training do not demonstrate statistically significant variation with AMT environment.

4.7.6 Propositions 4.11 and 4.12

MULTIPLE REGRESSION analyses were performed for both manufacturing and employee performance as a function of TQM, JIT and all practices and practice combinations. These activities were performed for the AMT environments of weak, average and strong. From examination and comparison of results an assessment of propositions 4.11 and 4.12 was made.

Table 4.23 gives the results of MULTIPLE REGRESSION analyses for the dependent variables of manufacturing and employee performance as a function of all practices and the IM facets of TQM and JIT for the AMT environments of weak, average and strong. Table 4.8 provides a similar analysis but for the IM facets of TQM and JIT only. Inspection of these tables shows that:

- dependent variable = employee performance. The adjusted $R^2$ varies from 0.406 (AMT weak) to 0.465 (AMT average) to 0.509 (AMT strong).

This finding, when combined with that of section 4.5.2 provides some support for Proposition 4.11. Note also that employee performance has a small positive association with AMT (refer Proposition 2.1 and Table 4.6). Consequently, the AMT environment is associated with employee performance and the strength of the relationship between various practices and (other) IM facets and employee performance

- dependent variable = manufacturing performance. The adjusted $R^2$ varies from 0.223 (AMT weak) to 0.267 (AMT average) to 0.285 (AMT strong).
### TABLE 4.22
Practices and AMT: Results of Discriminant Analysis

<table>
<thead>
<tr>
<th>FUNCTION NO.</th>
<th>CANONICAL CORRELATION COEFFICIENT</th>
<th>CHI SQUARED</th>
<th>SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.325</td>
<td>136.2</td>
<td>≤ 0.0000</td>
</tr>
<tr>
<td>2</td>
<td>.149</td>
<td>24.3</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

| STRUCTURE LEADINGS              | \( F_{N1} \) | \( F_{N2} \) |
| BENCHMARKING (*)                | .701         | .352         |
| TEAMS (*)                       | .246         | -.057        |
| PLANNING                        | .186         | -.061        |
| HR MANAGEMENT (*)               | .242         | .492         |
| LEADERSHIP (*)                  | .004         | .309         |
| TRAINING                        | -.072        | .192         |
| CHANGE                          | -.070        | -.098        |

\% CASES CLASSIFIED CORRECTLY = 47.6\

(*) SIGNIFICANT IN AT LEAST ONE DISCRIMINATING FUNCTION (≤ .05)
### TABLE 4.23
JIT, TQM, Practices, Employee Performance and Manufacturing Performance: Results of Multiple Regression Analyses for Weak, Average and Strong AMT Environments

<table>
<thead>
<tr>
<th>AMT ENVIRONMENT</th>
<th>MANUFACTURING PERFORMANCE</th>
<th>EMPLOYEE PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADJ. R²</td>
<td>F</td>
</tr>
<tr>
<td>WEAK</td>
<td>0.223</td>
<td>10.40**</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>0.267</td>
<td>13.24**</td>
</tr>
<tr>
<td>STRONG</td>
<td>0.285</td>
<td>13.69**</td>
</tr>
</tbody>
</table>

** Denotes signif at < .05
* Denotes signif at < .10
This finding, when combined with that of section 4.5.2, provides some support for proposition 4.12. Note also that manufacturing performance exhibits no statistically significant variation with AMT environment (refer Proposition 2.2 and Table 4.6). Consequently, the AMT environment is not associated with manufacturing performance, per se, but is associated with the strength of the relationship between various practices and (other) IM facets and manufacturing performance.

4.8 Chapter Summary

The description of results commenced by examining summary statistics for each of the 12 constructs considered and the variable of company size. The results indicated that firms make substantial levels of investment in all areas with the possible exception of AMT. AMT responses were generally low ranging from 2.07 to 3.08 (on a scale of 1 to 5) with the majority of responses less than 2.80. It was noted that the AMT questions used a hybrid scale which measures extent of use and perception of value. Consequently it is not possible to assess whether low responses reflect low levels of use, low perceptions of value or some combination. The results also indicated moderate levels of both employee performance and firm performance. Moderate levels of employee performance were most evident in responses to the questions measuring productivity and industrial disputation. Moderate levels of manufacturing performance were most evident in responses to the questions measuring cash flow and the ability to deliver in full on time to customers.

The bivariate relationships between constructs were described in the second section. The results indicated associations between employee performance and manufacturing performance, most IM facets and practices, most practices and employee performance and most practices and manufacturing performance. In respect to associations with performance constructs, notable exceptions include AMT and employee performance, AMT and manufacturing performance, benchmarking and manufacturing performance, benchmarking and employee performance and teams and manufacturing performance.

The discussion of the proposition sets 1, 2, 3 and 4 (refer Table 4.1) was performed in Sections 4.4, 4.5, 4.6 and 4.7 respectively. These sections discussed the analytical technique applied and presented the results of the analysis. Section 4.5 also included additional discussion on the AMT construct which failed to have an association with manufacturing performance for the total population. This analysis provided further insights into the value of AMT by identifying some of the conditions under which positive associations with manufacturing performance are found and demonstrating the relationship between the strength of the AMT environment and the magnitude of the associations between JIT and manufacturing
performance and TQM and manufacturing performance. Key findings included (specific proposition references in brackets):

- A strong positive association between employee and manufacturing performance (1).
- TQM, JIT and AMT are all positively related to employee performance (2.1).
- TQM and JIT are both positively related to manufacturing performance. AMT appears to have no direct relationship with manufacturing performance (2.2).
- The interactive effects of TQM, JIT and AMT have a small (but statistically significant) effect on employee and manufacturing performance (2.3 and 2.4).
- Weak performance (employee and manufacturing) is generally associated with weak levels of investment in TQM, JIT and AMT (2.5). However firms weakest in manufacturing performance are weak in TQM and JIT but strong in AMT. The difference in the mean value of manufacturing performance for this group and the group with low levels of investment in AMT, JIT and TQM is statistically significant (2.6).
- Strong performance (employee and manufacturing) is generally associated with strong levels of investment in TQM, JIT and AMT (2.7 and 2.8).
- The greater the level of investment in AMT the weaker the correlation between employee and manufacturing performance (2.9).
- The employee performance environment appears to have no significant impact on the correlation between AMT, JIT, TQM and manufacturing performance (2.10).
- A general strong level of association between AMT, JIT and TQM and the seven practices of interest. Associations are strongest between TQM and practices. (3).
- Practices explain additional variance in performance (both manufacturing and employee) after the effects of IM facets have been considered (4.1 and 4.2).
- Certain practices (eg. benchmarking and teams) moderate/increase in the correlation between IM facets and performance (4.3 and 4.4).
- The strongest correlation between practices and IM facets is found in firms with strong employee and weak manufacturing performance (4.5).
- The weakest correlation between practices and IM facets is found in firms with weak employee and strong manufacturing performance (4.6).
- The manufacturing performance environment appears to have little impact on which IM facets and practices contribute to employee performance (4.7).
- The employee performance environment appears to have little impact on which IM facets and practices contribute to manufacturing performance (4.8).
• TQM is a stronger differentiator of performance between groups with low-medium levels of manufacturing performance than groups with medium-high levels of manufacturing performance (4.9).

• Stronger AMT environments are associated with higher levels of benchmarking, teams, planning and HR Management (4.10).

• JIT, TQM and the seven practices have a stronger association with both employee and manufacturing performance in strong AMT environments (4.11 and 4.12).

Additional findings:

• AMT is positively and significantly associated with manufacturing performance but only in a strong AMT environment.

• The stronger the AMT environment the stronger the correlation between TQM and JIT and employee and manufacturing performance.

• The greatest use of teams and benchmarking is found in firms with strong employee but weak manufacturing performance. The difference in the mean value of teams and benchmarking between these firms and those with strong employee and manufacturing performance, is statistically significant.

Table 4.24 summarises classifies the results for each proposition using four categorisations:

• supported unconditionally: the analysis supports all aspects of the proposition,

• supported conditionally: the analysis supports only some aspects of the proposition (an issue of proposition definition),

• partial support: the analysis provides only partial support for the proposition (an issue of statistical power),

• not supported: the analysis refutes the proposition

These findings will be discussed in considerable detail in Chapters 6 and 7.
<table>
<thead>
<tr>
<th>Prop'n</th>
<th>Description</th>
<th>Support</th>
<th>Support</th>
<th>Partial</th>
<th>Not</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unconditional</td>
<td>Conditional</td>
<td>Support</td>
<td>Supported</td>
</tr>
<tr>
<td>1.</td>
<td>Strong manufacturing performance is positively related to strong employee performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Facets of IM (AMT, TQM, JIT) are positively related to employee performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Facets of IM (AMT, TQM, JIT) are positively related to manufacturing performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>The interactive effects of IM (AMT, TQM, JIT) are positively related to employee performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>The interactive effects of IM (AMT, TQM, JIT) are positively related to manufacturing performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Firms weak in all facets of IM (AMT, TQM, JIT) have weak employee performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Firms weak in all facets of IM (AMT, TQM, JIT) have weak manufacturing performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Firms strong in all facets of IM (AMT, TQM, JIT) have strong employee performance</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2.8</td>
<td>Firms strong in all facets of IM (AMT, TQM, JIT) have strong manufacturing performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2.9</td>
<td>The correlation between employee and manufacturing performance is positively related to facets of IM (AMT, TQM, JIT).</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>The stronger the employee performance environment, the stronger the correlation between facets of IM (AMT, TQM, JIT) and manufacturing performance.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.24  Summary of Key Findings (2/3)

<table>
<thead>
<tr>
<th>Prop'n</th>
<th>Description</th>
<th>Support</th>
<th>Support</th>
<th>Partial</th>
<th>Not Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unconditional</td>
<td>Conditional</td>
<td>Support</td>
<td>Supported</td>
</tr>
<tr>
<td>3.</td>
<td>That a specific set of practices/organisational attributes differentiate weak and strong IM environments.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.1</td>
<td>That (after the variance in employee performance due to IM facets has been considered) practices explain additional variance in employee performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.2</td>
<td>That (after the variance in employee performance due to IM facets has been considered) practices explain additional variance in manufacturing performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.3</td>
<td>That specific organisational practices enhance/moderate the relationship between IM and employee performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.4</td>
<td>That specific organisational practices enhance/moderate the relationship between IM and manufacturing performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.5</td>
<td>That the correlation between IM and practices is strongest in environments with weak people and strong manufacturing performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.6</td>
<td>That the correlation between IM and practices is weakest in environments with strong people and weak manufacturing performance.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4.7</td>
<td>That the manufacturing performance environment influences which practices and IM elements contribute to employee performance and their relative contribution.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Prop'n</td>
<td>Description</td>
<td>Support</td>
<td>Support</td>
<td>Partial</td>
<td>Not Supported</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------------</td>
</tr>
<tr>
<td>4.8</td>
<td>That the employee performance environment influences which practices and IM elements contribute to manufacturing performance and their relative contribution.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.9</td>
<td>That TQM has a greater power in differentiating firm manufacturing performance between low levels of performance (low/medium) than high levels of performance (medium/high).</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.10</td>
<td>That stronger AMT environments are associated with stronger practice environments.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.11</td>
<td>That the correlation between practices, TQM and JIT and employee performance is enhanced by a strong AMT environment.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.12</td>
<td>That the correlation between practices, TQM and JIT and manufacturing performance is enhanced by a strong AMT environment.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RESULTS OF QUALITATIVE ANALYSIS

5.1 Introduction

This chapter presents the results of qualitative analyses concerned with the adoption, implementation and assessment of value of investments in hard AMT (referred to as AMT), JIT, TQM and various organisational practices. A total of 12 firms are considered. Table 5.1 provides key data on each firm studied.

As discussed in Chapter 3, this area of research examines three issues:

- **Implementation.** Firm’s approach to the implementation of TQM, JIT, AMT and practice investments,
- **Causality.** Do investments lead to superior performance outcomes or are firms demonstrating superior performance more predisposed to make IM facet and practice investments?
- **Value Adding Mechanisms.** Assuming that investments can, and do, lead to improvements in performance, the mechanisms by which this occurs.

The first dot point is evaluated by considering the following change considerations:

- the forces for change (factors determining the organisation’s need for change),
- the existing work environment (factors affecting the organisation’s ability to change),
- the planned change process and its relationship to the manufacturing strategic plan,
- the actual change process (what happened, why it happened, who was involved, how they became involved etc),
- the barriers to implementation and how they were addressed,
- key learnings.

The second and third dot points are concerned with the relationships between investments in IM facets and practices and improved manufacturing performance. In particular this area of research is concerned with:

- the identification of the key performance categories and capabilities that are critical to firm success,
- quantitative outcomes. The impact of these investments on key performance categories (eg. product quality, employee productivity, employee strength, cycle time and unit cost),
- qualitative outcomes. The impact of these investments on organisational capabilities such as shared vision, shared values, distributed leadership and teamwork.
Figure 5.1 provides a pictorial representation of the organisation of material in this chapter. The change strategy is developed by firms to close the gap between the existing state and some desired (future) state. Consequently its examination needs to consider both the starting point for change and the desired outcome from the change process. Section 5.2 presents a discussion of two of the principal inputs into the change strategy: the change drivers (the forces for change) and change environment (characteristics of the work environment affecting the organisation's ability to change). We describe how these attributes vary across sites and how this variation impacts on the change strategy developed at each location. Section 5.3 is concerned with the change strategies and strategic management processes adopted by the various sites. The relationship between change strategy and manufacturing strategy is also considered. Section 5.4 considers the actual change activities that occurred. Amongst the perspectives considered are the sequence of events, the processes for involvement and deviations from the change strategy. Sections 5.5 and 5.6 present discussions of outcomes and barriers to change respectively. Key learnings and the relationship between the outcomes of this analysis and the quantitative analysis are discussed in conclusions (Chapter 6).

Written analyses of multiple case studies may take a number of different forms. One approach is to present each individual case as a narrative and analyse the information acquired. A second approach describes individual cases in traditional narrative form but also includes a section covering cross-case analysis and results. A third format consists of a discussion of cross case analyses and does not include sections devoted to each individual case.

The presentation of material in this chapter principally uses the third approach with change drivers, work environment characteristics, outcomes and barriers having been developed through cross-case analyses. However, the change strategy and change activity sections are concerned with the actual processes that occurred at each site. As the change strategy processes were similar across all 12 firms, one case, Kellogg, has been documented in detail with other firms' approaches considered as variations. In contrast, there was a large degree of variation in the change activity that occurred within firms. This variation was observed in many areas, for instance, what interventions and practices were implemented and in what sequence, who was involved and why, how they were involved etc. Consequently it was not possible to identify a generic implementation process and represent the other 12 cases as variations. It was also not practical to describe in detail all 12 cases. Here a compromise approach was adopted with 3 cases discussed in detail.
Table 5.1 Case Vignettes

<table>
<thead>
<tr>
<th>AMT Legend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAM</td>
<td>Computer Aided Manufacturing</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>CBT</td>
<td>Computer Based Training</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Drafting</td>
</tr>
<tr>
<td>MRP II</td>
<td>Materials Requisition Planning (II)</td>
</tr>
<tr>
<td>AMHS</td>
<td>Advanced Materials Handling System</td>
</tr>
<tr>
<td>EDI</td>
<td>Electronic Data Interchange</td>
</tr>
<tr>
<td>FMS</td>
<td>Flexible Manufacturing Systems</td>
</tr>
<tr>
<td>CNC</td>
<td>Computer Numerically Controlled</td>
</tr>
</tbody>
</table>

Case No 1. Australian Newsprint Mills

ANM is Australia's only large producer of newsprint. It has two mills: one at Albury (NSW) and the other at Boyer (Tasmania). The Boyer Mill is the slightly larger of the two and serves as the focus for this case. This mill employs over 1200 people, produces 240,000 tons of newsprint per annum and has a sales turnover in the order of A$200M per annum.

The mill commenced a major change process during the early 1990's after finding itself uncompetitive by world standards. This process had in excess of 20 elements. Key elements included a A$50M capital investment in new plant and technology (CAM, IT, CBT), TQM, organisational restructuring and work redesign, team development, widespread industrial reform and skills development. The change process involved the company's workers and managers as well as the union in a joint, consultative processes. Key learnings relate to the ability to introduce a comprehensive change process in a difficult business environment, overcoming resistance to change and developing a customer service work ethic.

Outcomes include improved quality and productivity, reduced manufacturing costs and labour. Relationships with suppliers have also improved substantially leading to significant reductions in the price of fruit and vegetables and increased processing yields.

Case No 2. Don Smallgoods

Don Smallgoods manufactures all types of smallgoods including hams, bacon, sausages, salami, continental sausages, pate and cooked meats. Don employs 450 staff and has a sales turnover in excess of A$100M per annum. Following the takeover of Don by Bunge Australia in 1989 a detailed audit was undertaken. This audit identified the need to reorient operations from production driven to customer driven and indicated the need for major reforms in the areas of quality, skills development, measurement, information systems and use of technology.

Through formal benchmarking and numerous visits to local companies in other industries, Don was able to prepare a vision for the future and develop a set of strategies with which to achieve it. A number of these strategies were combined in an organisational change process commenced in July 1991. This process focused on TQM but also incorporated aspects of AMT (eg. MRP II and CAD) in addition to other organisational practices. Through these interventions Don sought to develop organisational capabilities which drive improvements in business performance. These capabilities included: a common vision, open communication, a customer first culture, a preparedness to challenge "old ways of working", measurement driven performance improvement culture and development of teams. Outcomes of the process included improved workforce literacy, closer employee/employer relationships and teamwork in addition to improved productivity, quality, responsiveness to order and safety.
Case No 3. Du Pont

Du Pont manufacture a range of specialty chemical products in five categories: healthcare, printing and publishing, agriculture, butacite (a safety laminate for plate glass) and industrial chemicals. Du Pont employs approximately 110 people and has a turnover of A$150M p.a. of which A$35M is export.

During the late 1980's Du Pont's film business was under threat due to the import of cheaper substitute products to the health care and printing and publishing markets. The company responded by commencing a major change process termed "Organisational Effectiveness" over the period 1990 - 1994. This process had six core elements:

- Introducing a Best Practice safety management philosophy.
- Initiatives to enhance product and process flexibility (JIT).
- Initiatives to improve product quality and customer service (TQM).
- Developing employees toward their full potential in ways that enhance their contribution to the business.
- Developing plant and technology to improve safety, quality, flexibility and profitability (AMT - CAM, AMHS, CAM).
- Driving business and organisational improvement through an appropriate set of performance measures.

Through these investments the following improvements have occurred: product quality - 500%, cycle time - 400%, productivity - 150%, unit costs - 40%, employment - 30%. On average employees have generated more than 30 improvement suggestions per month since the process commenced in 1990.

Case No 4. Edgell Bird's Eye

Edgell Bird's Eye (EBE) is Australia's largest producer of frozen and canned vegetables. EBE distributes its own brand names (Edgell, Birds Eye, Country Harvest, Green Dragon) as well as various private and generic grands to major retail chains and wholesale outlets throughout Australia. The company has eight processing plants manufacturing frozen and canned foods in five states. Sales turnover is approximately A$600M p.a. and the company employs in the order of 2500 people.

In the late 1980's, declining business performance and increased competitor activity resulted in company recognising that it needed to become internationally competitive in terms of cost, quality and responsiveness if it was to secure its future. As a consequence six major reforms were introduced:

- Extensive technological upgrading of plant and equipment (AMT - CAD, CAM, IT, EDI, MRPII),
- Initiatives to improve the performance of suppliers and growers (JIT),
- Initiatives to improve customer focus and product quality (TQM),
- Organisational restructuring,
- Workplace reform (empowerment and team development),
- Development of human resources.

In September 1991 EBE was acquired by Pacific Dunlop. Pacific Dunlop brought an entirely new culture to the business. EBE was virtually an agricultural business that had its origins in conservative rural communities. Pacific Dunlop were known for their business acumen. Pacific Dunlop subsequently implemented a number of transformational business reforms (site closures, product rationalisation, redundancies and further capital investment) which significantly impacted on EBE's transitional change process. Business and organisational performance has shown only marginal improvement since the commencement of the change process.
Case No 5. Exicom

In September 1988, Exicom acquired AWA's Australian and New Zealand Telecommunications Division making it the largest Australian-owned group of telecommunications companies. Exicom employs more than 700 people in research and development; design; electronic and electro-mechanical assembly; precision metal fabrication; plastic injection moulding; distribution; and customer support and installation. The plant manufactures, on average, 6,500 telephones/day.

The acquisition brought extensive technological skills and state-of-the-art manufacturing facilities in addition to many of the problems that accompany "traditional" organisations (manufacturing driven/low customer awareness, high control culture, adversarial employee/employer relationship, restrictive work practices etc). Exicom responded to these challenges by undertaking a change process consisting of the following activities:

- the implementation of TQM
- benchmarking other operations to identify opportunities for improvement
- investing in human resource management processes (communication, recruitment, development and progression)
- introduce team based work structures.

Outcomes obtained include improved quality and productivity, the development of quality and time as core employee values and an improved employer/employee relationship.

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Case No 6. Fibremakers

Fibremakers is a manufacturer of Nylon and Polyester for Australian textile and carpet industries. Although the principal market is domestic, a small but increasing percentage of final product is exported. Fibremakers was acquired by Du Pont in June 1990 as part of its Asia Pacific expansion program. At that time the operation employed approximately 1800 people, was losing approximately A$30M/annum, had a labour turnover of 44%/annum and a lost time injury frequency rate over 100 times that of the worldwide Du Pont average.

Fibremakers change process was launched during the third quarter of 1990 and consisted of two key elements: safety management and supply chain management. The safety management process aimed to import the Du Pont international safety culture to the site and build a platform of values, attitudes, behaviours, tools and techniques which could be diffused to other areas of business activity (eg. quality and cost) to effect improvement. The supply chain management process was a hybrid TQM and JIT activity which applied a structured methodology to optimise the order to delivery process along the axioms of quality, time and cost.

Today the operation employs 500 people, is marginally profitable, has a labour turnover of approximately 3% and a safety performance that equates with Du Pont norms and which is substantially superior to the vast majority of comparable Australian firms.
Case No 7. Kellogg

Kellogg is the largest manufacturer of Ready To Eat (RTE) breakfast cereals in Australia having approximately 50% of market share. Kellogg employs approximately 800 people and is also Australia's single largest purchaser of corn and rice. Sales exceed A$350M per annum and 9% of sales are exported to 25 countries in the Asia Pacific Region. Kellogg aim to export 40% of total sales to Asia by the year 2000.

In order to achieve this export objective, Kellogg recognised that it needed to not only substantially increase its manufacturing capacity, but also become internationally competitive in terms of product quality, cost and reliability of delivery. A comprehensive change strategy known as the Asia Competitiveness Strategic Plan was developed in 1988 to pursue these objectives. The strategy consisted of three stages:

- Stage 1: Setting the climate/breaking down the barriers (1988 - 1992)

This extremely comprehensive change strategy included an investment of A$1000M in new plant and technology (FMS, AMHS, CAD, CAM) a suite of investments in areas including TQM, JIT, benchmarking, leadership, training, team development and human resource management.

The case study was undertaken at the end of 1994 and during the six year period since the change process was commenced, plant capacity had increased by 50%, product quality had increased by 50%, unit production costs had reduced by 40% and order to delivery time had reduced by 60%. Exports equated to 21% of total sales at that time.

Case No 8. Murray Goulburn

Murray Goulburn manufacture a range of dairy products. The company's suppliers produce more than 1400 million litre of milk per annum which is manufactured into a wide range of butter, cheese, milk and skim milk products. Murray Goulburn produces approximately 20% of Australia's total milk supply and the firm employs approximately 340 persons.

Due to industry deregulation and the entry of European producers into the domestic marketplace over the period 1988 - 1992, Murray Goulburn recognised the need to develop internationally competitive standards of performance in quality, cost and delivery in order to secure its future. Also, legislation introduced during 1991/1992 stipulated stringent health requirements regarding Salmonella, Listeria, Staph and E Coli. As a consequence Murray Goulburn needed to make considerable changes to its methods of production, quality policies and the attitudes and values of its employees. Quality became a key driving force for improvement. Murray Goulburn responded to these challenges by introducing a change strategy predicated on the TQM philosophy. Key activities undertaken included the development of customer service agreements, quality accreditation, process redesign, increased employee involvement and participation and formation of team based problem solving teams.

Changes in personnel and operational priorities during the change process caused a considerable number of problems including resource limitations, priority changes and slippage. Outcomes achieved have been minimal and include small improvements in product quality, cost of quality and labour turnover.
Case No 9. Pampas

Pampas is Australia's largest supplier of frozen sheet pastry, manufacturing approximately 90% of all sheet pastry used within Australia. The company also manufacture a range of frozen pastry products for the domestic marketplace including pastries, savories and desserts and are the sole supplier of apple pies to Macdonald’s Australian operations. Pampas employs approximately 150 people, produces an average of 50 tonnes of pastry per day and has sales of approximately A$180M per annum.

Pampas realised that its opportunity for growth in Australia was limited and recognised that if the company was to expand it must find alternative markets. However to win sales in other markets Pampas needed to upgrade its technology and improve its standards of performance in areas including delivery and quality. Further pressure for change came from Macdonald’s as Pampas’ apple pies did not meet quality standards and were expensive. In 1990 Pampas developed an integrated change strategy consisting of a number of elements. Key elements included:

- The introduction of TOM to improve product quality, reduce waste and reduce cost
- Benchmarking technology and organisational practices
- Injection of A$5M Capital investment in computerised process control technology (CAM)
- The introduction of teams to pursue the development of an empowered workforce.
- Industrial Relations reforms

Improvements achieved include a 35% increase in capacity, 15% increase in quality, increased workforce skills and increased workforce understanding of company direction.

Case No 10. Pacific Dunlop Bedding

Pacific Dunlop Bedding is the leading supplier of bedding in Australia and makes a variety of bedding products and sofas under brand names including Sleepmaker, Slumberland, Dunlopillo, Simmons and Lullaby. The company employees 600 people with sales in the order of A$400M per annum.

During the late 1980's, Pacific Dunlop Bedding's performance declined as a consequence of the entry of a large number of small manufacturers into the market place. These manufacturers offered a broad range of superior quality products at cheaper cost and in shorter delivery times. Pacific Dunlop Bedding produced a wide range of products and had the image of a company that was unresponsive to change and production driven rather than market driven.

By 1990 Pacific Dunlop Bedding management recognised the need to define, implement and sustain "best practice" in response to the increasing need to become internationally competitive in cost, quality and responsiveness. During its 5 year planning process in 1991 Pacific Dunlop Bedding formulated a strategic model for change. The model consisted of 4 elements and a number of key activities including:

- the introduction of leading edge production technology (AMT - CNC machines)
- the introduction of JIT to support a time based competitive advantage (JIT)
- further training and development to support the company's quality culture (TOM)
- the standardisation of processes and products
- employee involvement, empowerment and participation

As a consequence of these and other investments made, product quality has increased 16%, plant reliability has increased 19%, manufacturing costs have reduced 16% and cycle time has reduced 11% over the period June 1992 to June 1994.
Case No 11. Smorgons
Smorgon is a leading Australian fabricator and distributor of steel reinforcing bar and fabric. The company employs approximately 200 workers from varying cultural and ethnic backgrounds and annual sales are in the order of A$150M.

Smorgon was acquired from the Humes group of companies in 1988. At that time sales and product prices were depressed as the demand for building products was decreasing due to the recession in the building industry. A new CEO was appointed in 1988 to reverse the trend. Key issues included: outdated plant and equipment, demarcation disputes, poor employee /employer relationships, high employee turnover, 24 different languages spoken on site and poor safety performance.

An integrated change strategy was developed to address these issues. This strategy is complex and incorporates many elements including TQM, JIT and AMT. Progress has been slow being hampered by entrenched union attitudes, job security fears and poor communications. Poor communications has been a particular concern for Smorgons as in excess of 90% of their workforce come from Non English Speaking Backgrounds (NESB). As a consequence the emphasis of the change process has shifted to literacy programs as a precursor to change as many employees neither understood nor could effectively adapt to workplace changes as they simply could not communicate effectively.

Quantitative improvements that have occurred have been small and patchy. In many areas no clear trend has emerged. For example, the manhours taken to produce a ton of product has fluctuated from 2.8 to 3.6 hours during the change process. At the time this study was undertaken (December 1994) the figure was 3.2 hours. A number of qualitative improvements were reported however including improved employer/employee relationship, enhanced customer focus and improved relationships with suppliers and contractors.

Case 12 South Pacific Tyres
South Pacific Tyres is Australia’s largest producer of tyres. The company manufactures new tyres for passenger cars, four wheel drive vehicles, light trucks, trucks and buses, agricultural and industrial equipment under the Dunlop, Olympic, Goodyear, Kelly and private brand names. South Pacific Tyres produce over 7.2 million tyres per annum, generate approximately $60 million from export sales, employ over 6400 people and have total sales exceeding A$1 billion per annum.

The number of domestic tyre manufacturers has been falling steadily since 1965 and by 1990 only three remained. South Pacific Tyres were aware that their technology and productivity were poor by international standards. Following an international benchmarking mission, a change process, termed the “corporate perfection strategy” was developed in December 1989 to close the gap between site performance and Best Practice. This framework had three key elements:

- Technology: the introduction of world class tyre manufacturing technology;
- Work Environment: the development of Best Practices in organisational design, leadership, training (including English literacy), information systems, safety and team development;
- People: developing employee capabilities as the centrepiece of competitive advantage

South Pacific Tyres recognised the interconnectedness between these three areas as visits to sites using new technology had demonstrated the need for substantial investments in people and organisational processes. Consequently, a comprehensive and integrated package of reforms was introduced during the period 1990 - 1994. These included an investment of A$400M in new plant and technology, TQM, JIT, team development, training, award restructuring and performance measurement systems. Improvements have occurred in many areas including a 300% step change improvement in productivity with the introduction of the new technology, a reduction in machine changeover time from 15 hours to 20 minutes and significant improvements in employee participation, empowerment and acceptance of change.
FIGURE 5.1
Model for Analysis of Qualitative Data

- Change Drivers
  - Section 5.2
- Change Environment
  - Section 5.2
- Change Strategy
  - Section 5.3
- Change Activity
  - Section 5.4
- Qualitative Outcomes
  - Section 5.5
- Quantitative Outcomes
  - Section 5.5
- Barriers To Change
  - Section 5.6
- Key Learnings
  - Chapter 6
5.2 Change Drivers and Change Environment

In order to fully appreciate the change process within each firm, in particular, what happened, why it happened, how it happened, who was involved, the barriers encountered and the main lessons learnt, it is important to understand the rationale for change and the firm’s “change environment.” In Table 5.2 we provide “shopping lists” of these issues extracted from the 12 case studies. The length of these lists reflects the degree of variation observed across the locations, thus supporting the need to develop an adequate understanding of these issues in order to compare and contrast change activities across sites.

For example, deteriorating product prices, the removal of protective tariffs or entry of competitors into established markets created a sense of urgency, and in some instances threat of closure, that pervaded a number of the organisations studied and clearly impacted on the change strategies adopted. Australian Newsprint Mills, Fibremakers and Edgell Bird’s Eye were examples of firms who found their performance to take a step change “into the red” as a consequence of changes in the business environment. Consequently change strategies were transformational in type, a broad suite of interventions targeting large improvements in short time frames. In these instances the threat of closure generally served to galvanise workers and management on one common objective, the reduction of operating costs. The change environment, however, differed substantially at each site and this impacted on the specific set of issues that each location needed to address and overcome in order to effectively implement and sustain large scale change.

Consider Australian Newsprint Mills. During the period from the seventies to early eighties, Australian Newsprint Mills was starved of capital for plant and equipment improvement with investment averaging less than A$1M p.a. Investment in human resource development was also virtually nil and the mill’s performance fell substantially behind its competitors. Australian Newsprint Mills benchmarked its performance and found that its:

- paper machines were narrow (6.5 mtrs). Best Practice was 10 mtrs.
- paper machines were slow (600 mtrs/min). Best Practice was 1100 mtrs/min.
- operation was overmanned (12 hours/tonne). Best Practice was 4 hours/tonne.
- operation had a poor safety record. Injury rates were 4 times higher than Best Practice.
- raw materials, energy and transport costs were significantly higher than Best Practice.
- paper quality was poor due to the old paper forming technology being used.
- environment performance was poor.
### Table 5.2 Change Drivers and Change Environment

(Compiled from the 12 cases examined)

<table>
<thead>
<tr>
<th>Change Drivers: Strategic</th>
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<tbody>
<tr>
<td>Survival (operation making a loss)</td>
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<tr>
<td>Declining profitability</td>
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<tr>
<td>Poor quality</td>
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<tr>
<td>Inadequate flexibility</td>
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<tr>
<td>Inadequate responsiveness</td>
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<tr>
<td>Regain lost market share</td>
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<tr>
<td>Growth: Domestic and International</td>
</tr>
<tr>
<td>Inability to meet current customer requirements or expectations</td>
</tr>
<tr>
<td>Maintain/Improve competitiveness</td>
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<tr>
<td>Loss of tariff protection</td>
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<tr>
<td>Entry of new competitors</td>
</tr>
<tr>
<td>Technological obsolescence</td>
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<tr>
<td>Compliance with environmental (emission) requirements</td>
</tr>
<tr>
<td>Declining competitiveness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change Drivers: Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce manufacturing costs</td>
</tr>
<tr>
<td>Increase capacity</td>
</tr>
<tr>
<td>Reduce direct labour</td>
</tr>
<tr>
<td>Improve productivity</td>
</tr>
<tr>
<td>Reduce inventory</td>
</tr>
<tr>
<td>Improve safety</td>
</tr>
<tr>
<td>Reduce cycle time</td>
</tr>
<tr>
<td>Poor supplier performance</td>
</tr>
<tr>
<td>Poorly skilled and under-utilised workforce</td>
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<tr>
<td>Poor workforce morale</td>
</tr>
<tr>
<td>Change Environment</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>• Personnel changes: Senior managers, management team and change champions</td>
</tr>
<tr>
<td>• Low past level of capital investment</td>
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<tr>
<td>• Lack of business understanding by the workforce (country club mentality)</td>
</tr>
<tr>
<td>• Minimal past exposure to change</td>
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<tr>
<td>• Lack of acceptance of change/inability to introduce and sustain change in the past</td>
</tr>
<tr>
<td>• Poor employee/employer relationship</td>
</tr>
<tr>
<td>• Poor workforce morale</td>
</tr>
<tr>
<td>• Barriers associated with employee awards</td>
</tr>
<tr>
<td>• Technological investments (generally large) not operating effectively and/or yielding envisaged gains</td>
</tr>
<tr>
<td>• Geographically dispersed resources/operating sites</td>
</tr>
<tr>
<td>• Poor level of workforce literacy</td>
</tr>
<tr>
<td>• Retrenchments</td>
</tr>
<tr>
<td>• High labour turnover</td>
</tr>
<tr>
<td>• Minimal spare resource capability</td>
</tr>
<tr>
<td>• High workload peaks (seasonality, shutdowns etc)</td>
</tr>
<tr>
<td>• High base workload</td>
</tr>
<tr>
<td>• Disenfranchised supervisory workforce: passive resistance to change</td>
</tr>
<tr>
<td>• Reactionary (firefighting) work ethic: minimal planning</td>
</tr>
<tr>
<td>• Industry and market volatility</td>
</tr>
<tr>
<td>• Employees strongly socialised to parent discipline</td>
</tr>
</tbody>
</table>
By the start of the 1990's this already bleak picture worsened dramatically due to a 23% decline in newsprint demand brought on by the recession in the Australian economy (sales of newsprint are heavily dependent on classified advertising which fell substantially during this period). Operating costs were also continuing to rise and overseas competitors were beginning to penetrate local markets with newsprint of superior quality. As a consequence, orders were lost and the established customer base was eroded. For the first time in its 50 year life, the mill operated at a substantial loss. The pressures for change were immense. As noted by the Human Resource Manager:

"As you can see from our background, our initial actions were driven by "change or perish". Bad news seemed to be coming from everywhere. We had known for a long time that we needed to change but we hadn't been able to achieve any real gains. It's fair to say that, to some extent, this had resulted in a management credibility problem. Now everybody knew that their jobs were on the line and we knew that a very direct management approach was needed but we had to overcome this legacy of the past. All the things we did were directed at getting quick runs on the board. Participation was to some extent compromised for expediency."

It was noteworthy that Australian Newsprint Mills had not received tariff protection and therefore the need for change was principally derived from the need to attain internationally competitive standards of performance in operating cost, product cost, product quality and on-time delivery. This position at Australian Newsprint Mills can be contrasted to that of Fibremakers. Up until 1990, Fibremakers were receiving bounty payments of $2.0M/month from the federal government and the operation was losing approximately A$2.3M/month (aggregate loss of A$0.30M/month). The operation also had extremely poor labour/management relations, a labour turnover rate of 44% and significant difficulty introducing even relatively simple improvements into its operations due to entrenched union attitudes. In June 1990, bounty payments ceased and Du Pont (Australia and New Zealand) purchased Fibremakers as part of its Asia Pacific expansion program. The majority of the management team was retrenched and replaced by Du Pont secondees, principally American. Therefore although the driving force for change in both Australian Newsprint Mills and Fibremakers was poor financial performance, the circumstances at the sites were very different. Fibremakers refurbished its plant during the mid eighties, investing A$25M in new technology, however, it had been unable to introduce the necessary organisational and human resource changes to realise the benefits of this technology. ANM had obsolete technology. An environment of relative industrial harmony existed at Australian Newsprint Mills whereas Fibremakers exhibited all the traditional adversarial labour relations characteristics. Australian Newsprint Mills were to drive the change process with a management team well known to all
employees, but lacking in "change management" credibility. Fibremakers were to drive the change process with a group of managers who were unknown to most employees but who had a proven record of delivering rapid change. Poor customer satisfaction was also a critical driver for change at Australian Newsprint Mills whereas poor safety performance was a key focus at Fibremakers. These differences in site environment had a substantial impact on the change processes employed by each site. For example, although both site's change processes emphasised short term gains, Australian Newsprint Mills placed considerable emphasis on overcoming industrial relations barriers. Fibremakers however, moved rapidly into a large relationship building exercise to give the new managers a chance to understand "the people and local site culture" and the employees a chance to get to know the new managers. The strategies for improving workplace culture were also very different at these sites. Australian Newsprint Mill's approach was to use technological change as an opportunity to make widespread changes to organisational and human resource systems. Fibremakers approach was based on the development of an effective safety culture and its diffusion into other areas of manufacturing activity.

The position at these sites can be further contrasted to that of Edgell Bird's Eye who like both Australian Newsprint Mills and Fibremakers exhibited poor financial performance and introduced many internal organisational reforms but differed in their substantial efforts to improve supplier performance. As noted by the change agent at Edgell Bird's Eye:

"During the late 1980's the company realised that its traditional markets were under threat ... these markets were being increasingly overrun by major competitors due to the internationalisation of business, more efficient freighting, tariff considerations etc. Due to all these factors our return on investment declined substantially and we realised we had to change. We also knew that a major part of our problem was our supplier problem. Raw fruit and vegetable costs were not competitive by international standards. For example, Australian potatoes cost us $210/ton whereas New Zealand potatoes are $130/ton and US potatoes are $100/ton. As these costs represent almost half of our total finished product costs we knew that we had to get grower's costs down."

EBE's change context also differed from both Australian Newsprint Mills and Fibremakers in that a corporate takeover occurred during the implementation of the change process. Edgell Bird's Eye were 18 months into a major change program when the company was sold to Pacific Dunlop. Pacific Dunlop took a number of major decisions to improve short term operational performance and communicate to the organisation the need to deliver substantial and rapid change. These decisions included: closing 3 sites, removing one level of middle management, over 200 staff retrenchments and "shelving" some aspects of the change
process. Consequently, unlike Australian Newsprint Mills and Fibremakers, EBE's change effort was confronted with the additional obstacle of maintaining commitment to a “bare bones” change program in an environment where many change champions had been retrenched, short term operational issues flourished, energy and enthusiasm were dissipated and resources were cut. Many Edgel Bird’s Eye employees also interpreted the actions taken by Pacific Dunlop as reflecting a low level of corporate confidence in EBE’s existing change program and therefore were reluctant to get involved.

These change imperatives and change environments were very different to those of Pampas, Pacific Dunlop Bedding and South Pacific Tyres. These businesses were all reasonably profitable, and change was driven by the need for business growth, changing customer needs, technological competitiveness etc. The change processes at these sites generally involved significant effort in overcoming resistance to change. This took the form of obtaining employee acceptance of company direction and “buy in” to the change process. Consequently, change processes were highly participative and consultative, typically involving a stream of interventions to produce continuous improvement, rather than step change. However the change environment at each of these sites differed substantially and the different issues and barriers that needed to be addressed had a substantial impact on the change strategy adopted.

Consider Pampas. The changes at Pampas were primarily derived from internal, rather than external considerations, notably market growth and changing customer performance standards. Pampas makes approximately 90% of all sheet pastry used within Australia using the Scotch method of pastry manufacture. With such a high market share and limited opportunities for domestic market growth, the company knew that if it was to expand it must find alternative markets. However, the international marketplace, particularly SE Asia and Europe, demanded pastries made using the French method. Compared to pastries made using the Scotch method, these pastries have lower fat content, are softer and easier to use and widely acknowledged as having superior taste. As each method uses different manufacturing technology, Pampas knew that its future growth depended on a $25M capital investment in AMT (Distributed Control System technology). Consequently its change effort was substantially technologically driven.

Pampas also demonstrated the characteristics of an organisation with a strong technological culture: sizeable R&D facility, strong functional representation in process technology, design, engineering and maintenance with 6 of the 8 members of the management team having a technological or engineering background. Therefore the introduction of new technology was implemented along traditional functional lines and accompanying adjustments to organisational systems and investments in human resources did not occur until performance deficiencies became evident. When these deficiencies did become evident, Pampas did not
have the resources to undertake the necessary changes and therefore consultants were used extensively to oversee the change process.

Pampas' change initiatives were also driven by customer (product quality) standards. Pampas were the sole supplier of Mc Donald's Apple Pies in Australia. Mc Donald's rate the quality of their apple pies by evaluating colour, crust, filling and flavour. Each attribute is ranked from zero to three giving a maximum rating of 12. Pampas' pies achieved a score of 6 (primarily due to the use of different fruit variety) compared to the international standard of 12. The cost of a case of rating 12 pies to Asian markets ex the US was also approximately A$3 per case (128 pies) less than a case of rating 6 pies delivered from Pampas in Australia. Consequently, Mc Donalds advised Pampas that it needed to substantially improve quality and reduce costs in order to remain its sole (and preferred) supplier of apple pies. As Mc Donalds represented in excess of 35% of Pampas' business and the relationship provided a substantial opportunity for growth in Asian markets, quality improvement and cost reduction became key strategic imperatives. Further, due to the established preferred supplier relationship with Mc Donalds, Pampas was able to gain access to pastry manufacturers used by Mc Donalds in other countries, benchmark their processes and practices and develop a clear agenda for improvement.

Changing customer needs was also a driving force for change at Pacific Dunlop Bedding. Yet unlike Pampas, they did not have a customer relationship with which to leverage improvement. During the late 1980's deregulation resulted in two key and interrelated marketplace changes that effected Pacific Dunlop Bedding: the entry of a large number of small firms into the marketplace and the fragmentation of large markets into small niche markets. Consequently, responsiveness to order, small production lots and price became key issues. Retailers responded to these challenges through aggressive marketing campaigns that required manufacturers to be able to adjust production schedules rapidly. Pacific Dunlop Bedding, was a large production oriented organisation which had the image of a company that was unresponsive to change and emphasised volume production at the expense of customer needs. Manufacturing performance was assessed on the basis of product volume and the cost of waste and materials storage were given a relatively low priority. By the end of the 1980's the company recognised the need for significant change. As remarked by Pacific Dunlop Bedding's General Manager:

"By 1990 the bedding industry had become fiercely competitive. Forecasting demand had become impossible given the wide range of products produced and the high service levels demanded by customers. Deficiencies in our operations were appearing everywhere."

Pacific Dunlop's response to this changing basis of industry competition was eloquently described by its National Manufacturing Manager:
“Today we don’t know what we are going to make from Monday to Friday and it is important for us to operate our business on JIT manufacturing principles. This has allowed us to reduce our lead times from 14 days to 24 hours. But we have also needed to get a better understanding of what customers want and design and operate our facilities accordingly. Consequently, TQM was a big part of our change strategy. TQM not only enabled us to reduce waste and rework by 15% but redesign our processes to further collapse lead times.”

South Pacific Tyres needed to confront a different set of issues. South Pacific Tyres, a highly profitable organisation, like Pampas, recognised that its core technology was becoming increasingly uncompetitive in terms of flexibility, quality and cost. South Pacific Tyres manufactured a broad range of passenger, truck and farm tyres for over 15 different domestic and international customers. The growth in product range and customer base had resulted in many problems related to production inflexibility and the company knew that its performance would continue to decline unless its core technology was upgraded.

South Pacific Tyres’ decision to invest A$400M in Mitsubishi Heavy Industries (MHI) tyre building technology in its Melbourne operation however resulted in a number of unique concerns. First the magnitude of the investment and the type of AMT (Computer Aided Manufacturing and Automatic Materials Handling equipment) used meant that substantial investments needed to be made in organisational and human resource areas but the level of commitment of resources to technological change made this extremely difficult. Second, as the total number of machines was to be reduced from 25 to 9, labour content would be substantially reduced and as a consequence retrenchments would occur. Many employees did not accept that this was necessary as the company remained highly profitable. The mindsets of many employees were firmly focused on successes of the past rather than future security and consequently overcoming resistance to change was a key issue. Third, the new technology was clearly the centre piece of the firm’s change strategy. However its introduction would not directly affect the work of some employees and there was a need to ensure the diffusion of change activities into these areas so that “pockets” of employees were not left behind.

In summary these examples illustrate that:

- different performance and competitive issues had a substantial impact on the change drivers and therefore objectives of the gap closing strategy (i.e. IM and practice investments) developed at each site.
- different change environments meant that different issues and barriers needed to be addressed and overcome and this also had a significant impact on the gap closing strategy developed at each site.
5.3 Manufacturing Strategy and Change Process Design

It is noteworthy that all 12 firms studied had developed detailed business plans which incorporated substantial manufacturing input although the timeframe and degree of detail varied as a function of the performance of the firm and volatility of the business environment. For example, Fibremaker’s plan was fundamentally generic with a mainstream focus on short term issues aimed at reducing the threat of closure. Du Pont’s business plan had a 10 year time horizon due to the relative stability of that particular business environment and the longer product life cycle. Alternatively, Exicom’s plan had only a 5 year time horizon, reflecting the shorter product life cycles that exist within the communications industry. Exicom’s plan also emphasised the development of strategic alliances due to the speed and scale of technological change within that industry.

At one of the sites studied, the business plan had not been updated in over 3 years and as a consequence was of dubious relevance to its operations. It is noteworthy that this was the only site studied that had introduced and subsequently withdrawn from service an AMT installation. This observation was consistent with those of the AMC (1994) who observed a number of plants where “islands of automation that had no clear relevance to business intent had been introduced and been subsequently abandoned” (Australian Manufacturing Council, 1994A, pp 58). However, with the available sample population, it is clearly not possible to investigate the extent to which the existence of a current strategic plan is associated with greater success in the use of AMT.

In respect to the development of manufacturing plans, all firms studied used processes that applied traditional strategic planning technologies. These processes consist of three key stages. The first, or NOW stage, consisted of an initial review of operations using some form of analysis or diagnostic. The second, or WHERE stage was commonly referred to as the Manufacturing Strategy. This stage defined the future state, typically in the form of a manufacturing mission, manufacturing objectives (growth, profitability etc), philosophy statement, core competencies and functional strategies. The third, or HOW stage, was commonly referred to as the change plan. This stage articulated the detailed set of action plans, interventions and measures used to achieve the future state. To illustrate how the 12 firms applied this process, consider Kellogg. Kellogg undertook a detailed benchmarking process involving senior managers from all international operations during the mid 1980’s. The results indicated that Kellogg Australia’s performance was the lowest of all affiliates in virtually all categories. Labour hours per ton of finished product were 300% (of Best Practice), raw materials usage 280%, waste and rework 250% and energy usage 200%. Quality and customer service performance was also extremely poor. A number of international site visits were
subsequently arranged, principally to Kellogg facilities, to understand and analyse differences in plant and technology, strategies, systems, organisation and work design, skills, processes, supplier arrangements etc. Deficiencies and shortcomings were subsequently analysed and improvement opportunities were identified. Kellogg wanted to ensure however, that any actions taken to correct operational deficiencies also contributed to the company’s future competitiveness. Consequently, significant effort was expended in the identification of future business opportunities. Believing that Asia may provide significant opportunity for growth Kellogg undertook detailed market research and concluded that:

- The Asian economies offered extraordinary business potential. Rate of market growth in Australia and New Zealand was approximately one sixteenth that of Asia.
- Over the next 25 years the Asian population was expected to grow from 1.5B to 1.9B. These figures reflected not only a population increase but the emergence of a growing and more affluent middle class.
- The traditional Asian breakfast was “fresh, soft, warm and soggy”. Kellogg produced ready-to-eat cereals that were “packaged, processed, cold and crisp”. Consequently comprehensive marketing and manufacturing strategies would be needed to change peoples’ eating habits and modify cereal specifications.
- Asian business viewed Australian manufacturers as:
  - production rather than market driven,
  - supplying produce of marginal, and in many instances, inferior quality,
  - inefficient, due to outdated manufacturing methods, poor labour relations practices and high raw materials costs,
  - unreliable, with deliveries often falling short of contractual obligations.

In 1988 Kellogg launched its Asia Competitive Strategic Plan (ACSP) which specified target markets and customers and defined the financial, marketing and manufacturing strategies and capabilities that were required. The key objective of this plan was to more than double output from the 1988 level of 45,500 tons to 100,000 tons by the year 2000. In manufacturing terms this translated into a massive technological, organisational and human resource investment program to increase capacity, introduce new processing and packaging facilities, develop a customer service mindset and improve efficiency. The mission statement developed for Kellogg was:

“*To become world class and be the principle resource and supply centre for the Kellogg Company’s Asia expansion program.*”

This mission statement served to drive improvement effort in all areas of Kellogg’s operations. Philosophy statements were also developed which defined the shared values that Kellogg
# Table 5.3 Mission and Core Values Statements (Examples)

<table>
<thead>
<tr>
<th>Case No 1. Kellogg</th>
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<tbody>
<tr>
<td><strong>Mission Statement</strong>: To become world class and be the principle resource and supply centre for the Kellogg Company’s Asia expansion program.</td>
</tr>
<tr>
<td><strong>Core Values</strong></td>
</tr>
<tr>
<td><strong>Strategic Intent</strong></td>
</tr>
<tr>
<td>Profitable growth is our primary purpose. To meet this commitment we will grow and expand our core business, strengthen our global leadership in ready-to-eat cereal, provide nutritious products of superior value and excel in the introduction of new products that meet consumer needs.</td>
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<tr>
<td><strong>People</strong></td>
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<tr>
<td>People our greatest competitive advantage. Each and every individual will be given the opportunity to reach their full potential and to contribute to and share in the company’s success.</td>
</tr>
<tr>
<td><strong>Customer Satisfaction and Quality</strong></td>
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<tr>
<td>The customer is the ultimate judge of our success and together with our suppliers and trade partners we will provide customers with products of superior value.</td>
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<tr>
<td><strong>Integrity and Ethics</strong></td>
</tr>
<tr>
<td>We will conduct our affairs in a manner consistent with high ethical standards by engaging in fair and honest business practices, showing respect and communicating in an honest, factual and accurate manner.</td>
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<tr>
<td><strong>Social Responsibility</strong></td>
</tr>
<tr>
<td>We are committed to being an economic, intellectual and social asset in the community by encouraging employees to participate in community programs, investing in activities and organisations that benefit the community and ensuring facilities, working environments and employment practices reflect good citizenship.</td>
</tr>
</tbody>
</table>
Case No 2. Australian Newsprint Mills

Mission Statement:
Our challenge is to Get Ahead, Stay Ahead and Grow our Future.

By achieving this Mission, we will create increasing value for our shareholders and a cash flow return in the upper quartile of newsprint producers worldwide.

Core Values:

Customers
We believe in strong partnerships with our customers. Our commitment is to provide unsurpassed quality and service in meeting their individual needs. We will seek similar relationships with our suppliers.

Environment
We believe in caring for our environment. Our commitment is to ensure all our policies and practices are consistent with community expectations and requirements.

Work Environment
We believe in the well being of all the people who work at ANM. Our commitment is to a healthy and safe working environment and to fairness and honesty in our dealings with one another.

Continuous Improvement
We believe there is always a better way. Our commitment is to strive for this in all we do.

Social Responsibility
We recognise that many of the resources that we use belong to society as a whole. We therefore commit ourselves to protect and develop those resources.

Employees
We make a commitment to accept that people are a valuable asset, responsible and trustworthy, that they are capable of making proper decisions related to their spheres of responsibility, that they can collaborate on such matters as operations, maintenance, problem solving and develop the power to act correctly from within the group.

Organisation
We make a commitment to develop an organisation that meets individual needs to:
- Have work content that is reasonably challenging
- Be able to learn and continue learning
- Know that you can rely on others
- Know your contribution to the end result
- Have an area of decision making
- Have a desirable future

Change:
We make a commitment to support an evolutionary process which continues to examine practices, determine strategies for overcoming obstacles as they arise, and predict and prompts change so that we are leaders and not victims of change.
Case No 3: Edgell Birds Eye

Mission Statement:
To be the best manufacturer and marketer of high quality branded commodity vegetables and composite food products providing convenience and ease of preparation for consumers.

Core Values:

Customers:
We will strive to exceed customer expectations and service standards.

Employees:
People are our most important asset. We commit to developing a work environment that is safe and challenging and encourages individuals to contribute to their full capacity.

Improvement:
We will develop work practices and exploit technological opportunities that will improve our business and organisational performance.

Teamwork:
We will operate in a team based environment where employees have a commitment to a shared vision. Work groups will be highly autonomous.

Communication
We will develop mechanisms that promote open two way communication between customers, shareholders, employees and the community.

Environment:
We will operate our facilities in a way that protects and sustains the environment and assist growers to improve their management of the environment.
would strive to develop. These values were defined around five axioms: strategic intent, people, customer satisfaction and quality, integrity and ethics and social responsibility. Table 5.3. gives the mission and values statements for Kellogg and two of the other firms studied (Australian Newsprint Mills and Edgell Bird’s Eye). Kellogg’s change process was to be implemented in three stages:

Stage 1: Setting the climate/breaking down the barriers (1988 - 1992)

Core activities within Stage 1 of the ACSP included the establishment of consultative, training and communications committees, A$400M capital investment in AMT (Flexible Manufacturing Systems, Automatic Materials Handling Systems and Computer Aided Drafting), the introduction of TQM (customer service agreements, Quality Accreditation and continuous improvement tools and techniques), JIT (spares rationalisation, supplier rationalisation/collaboration, preventative maintenance and process coupling), award restructuring, enhancement of safety performance, progressive removal of demarcations and the introduction of team based structures.

Under ACSP Stage 2, Workplace Reform is be undertaken over the period 1991 to 1996. It focuses on the development of a modern, flat organisational structure underpinned by the concepts of employee empowerment and commitment. Core activities under Stage 2 included A$200M capital investment (further Flexible Manufacturing Systems and Automatic Materials Handling Systems), the encouragement of union rationalisation, productivity and incentive schemes, development of employee leadership capability, progressive development of team based work structures, literacy and numeracy training, benchmarking, work design and gain sharing.

ACSP Stage 3 is aimed at harnessing the potential of a skilled, empowered and committed workforce for continuous improvement and innovation. Key tasks planned include, A$400M capital investment in AMT, lifting productivity and efficiency targets, refining the team based approach to work, increased use of information systems, developing training programs appropriate for multifunction operations and accelerating exports.

Examples of the change processes used at 3 other sites are given in Table 5.4. Within Kellogg the manufacturing strategic plan and the associated change process are “living” documents and considerable emphasis is placed on obtaining employee input. When formulated in draft form, each staff member attended a two day briefing in which the background and content of the documents were discussed and debated in detail. Consequently all staff had an opportunity for input into the direction of the company and the change process to be used and as a result greater levels of employee understanding and ownership were
TABLE 5.4
EXAMPLE OF CHANGE PROCESS

Dunlop Bedding Change Model

- Best Practice
- Process and Product
- Employee Involvement
- Systems
- Technology
- Productivity Improvement

Customers
Accompanying notes to Dunlop Bedding Change Model

The model consists of four integrated elements:

Employee Involvement and Participation
At the core of the model is the approach to employee involvement and participation in structured productivity programs. Pacific Dunlop Bedding view employee capabilities as the centrepiece of their competitive advantage.

Systems (JIT, Quality Accreditation, EDI, EDP etc)
Pacific Dunlop Bedding have invested in development, implementation and improvement of various leading edge systems to drive the business. The systems are externally oriented, focussing on the company's customers and extending right through the business to suppliers. Systems include aspects of TQM, JIT and AMT infrastructures. Key systems include:
- JIT links from customer to supplier to support a time-based competitive edge,
- Internal visible operational systems (eg. Kanban systems), driven by work groups.,
- Electronic Data Interchange (EDI) between with both customers and suppliers.
- Electronic Data Processing systems used at all levels of the organisation to support a “minimal inventory and responsive” business culture.
- The development of systems to support the company’s quality culture, in particular quality accreditation.

Technology (Manufacturing Technology)
Pacific Dunlop Bedding have an investment program to ensure technological competitiveness. For example, in the spring manufacturing plant in NSW, the company has committed $3.5 million over three years to upgrade to state of the art technology, making new and innovative products which are not available in Australia. Dunlop Bedding also invested $2.2 million during 1993 to equip each plant with the very latest technology in quilting and cutting systems. The equipment is computer controlled, flexible and high speed operating at three times the speed of conventional equipment. It also incorporates unique waste reduction features.

Products and Processes
A key element of Pacific Dunlop Bedding's change process is the standardisation of products and processes, on a national basis, across all operations. This element of the change process focuses on two key areas:
- The standardisation of components, national specifications and national processes.
- The co-ordination of product development and testing.

This element of the model is underpinned by the establishment of a central Product Research and Development facility. The company's international network of industry contacts has assisted the company to pursue best practice in this change element.
Accompanying notes to Pampas Change Model

Stage 1: Climate Setting
This consisted of a number of briefings to all employees explaining the objectives of the program and their role in the process. Question/answer sessions were included.

Stage 2: Strategic Planning
Identifying strengths, opportunities, weaknesses and threats, preparing a vision statement, identifying key result areas, developing objectives and action plans and listing an appropriate set of performance measures.

Stage 3: Process Analysis, Work Organisation, Productivity Measures And Benchmarking
An extensive training effort in hardcore process mapping and process analysis techniques, emerging BP organisational concepts, teamwork and development and use of performance indices. Benchmarking training was included for those involved in the second benchmarking trip to evaluate international best practices in respect to organisational development.

Stage 4: Job Design
The development of expertise in the use of socio-technical system methodology, the performance of a job design exercise and the preparation of organisational and job options.

Stage 5: Skills Analysis And Skills Audit
The development of facilitators, preparation and administration of a draft questionnaire, and the analysis of information and the preparation of a report.

Stage 6: Training Plan
The development of a detailed site wide training program to introduce the required changes.

The plan was ambitious, comprehensive and extensive and served to co-ordinate and direct all consultative committee activities under this project.
Du Pont
Mission Diagram

DU PONT (AUSTRALIA) LTD
"WORLD CLASS"

TEAMWORK

GROUN

GROUN

CONTINUOUS IMPROVEMENT

CORE PROCESS

INCREASE "ORDER"
& "FREEDOM"

SECURITY

RIGHTS OF INDIVIDUAL
IN A TEAM

VISION

USER

VALUE

QUALITY

EMPLOYEE GROWTH

SERVICE

SHAREHOLDER

COMMUNITY

COMPETITION

OUTPUTS

CUSTOMERS

FACILITIES PLANNING

QM

METRICS

SCM

DEVELOPMENT

CORE PROCESS

CAPITAL

MANPOWER

TECHNOLOGY

LEVERAGE

INFORMATION

RESOURCE

CORE PURPOSE
"CONTINUOUS IMPROVEMENT THROUGH PEOPLE"
Accompanying notes to Du Pont Change Model

The core process philosophy is based on the principle that the workforce are empowered and given leadership training in order to manage their own processes. Management focus on the development of work environments that supports new ways of working.

The workforce is encouraged to introduce streams of improvements in 6 key core processes:

- Safety, Health and the Environment
- Product Development
- Supply Chain Management
- Quality Management
- Measurement
- Facilities Planning

Through introducing streams of improvements in these six processes, Du Pont seeks to realise superior performance outcomes in all key areas of the business and satisfy the needs of shareholders, employees, customers and the broader community.
obtained. The manufacturing strategic plan and change process are subject to regular review and discussion in the light of emerging issues and trends.

Ownership for the implementation of the change process rests with the site consultative committee, a committee consisting of 6 managers and 6 employees. This collaborative approach has helped to ensure that the plan remains relevant and current and that employee related issues are given the appropriate priority. It is also noteworthy that the same committee oversee technological, organisational and human resource investment strategies.

As noted earlier, all of the organisations studied demonstrated a surprising degree of consistency in their planning processes. Five key issues, however, differentiated many firms specific activities and were found to have substantial impact on the implementation of AMT, JIT, TQM and practice investments and the subsequent impact of these investments on performance. Below, each of these issues is described and its impacts are briefly discussed.

5.3.1 Issue No 1. The level of employee involvement.

Some firms did not make the same level of investment as Kellogg in obtaining employee buy in to the manufacturing plan and change process. For example, Australian Newsprint Mill's and Exicom's processes involved one member of the senior management team preparing the plan, organising board approval and "selling" the plan to heads of departments. As a consequence there was a view by some senior managers that strategic planning exercises had become little more than exercises for generating lengthy wish lists. As remarked by a manager:

"While each individual item, an expanded product range, broader market coverage, faster new product development, lower costs, better quality, shorter lead time etc is admirable in isolation, collectively they paralyse the firm. We need to make sure that plans are realistic, and include everyone's input, otherwise they're just 'white papers'."

Furthermore, many employees at these sites were unaware of the plan, or if aware, considered it to have relatively little impact on their work. Consequently, at an operational level, the work ethic was more characteristic of a "fire fighting" group (Adler, McDonald and Mac Donald, 1994) whose priorities continually change in response to changing business requirements. This situation can also be contrasted to that of Du Pont where the strategic plan was the centre piece of all managerial effort to improve employee understanding of the business' future direction and the key challenges that it faced.

5.3.2 Issue No 2. Integration of the Manufacturing Strategy with the Change Process

Many firms differed from Kellogg in the level of connectedness between the manufacturing strategy and organisational change process. For example, in some firms
different individuals and groups were involved. The situation at Pampas was typical of this situation. At Pampas different senior managers were responsible for the development of the manufacturing plan (setting long term direction, identifying sources of competitive advantage, setting business objectives etc) and the development/implementation of the change plan (TQM, benchmarking and team development). Consequently, one group lacked understanding of the issues involved in developing Best Practices and the other group lacked appreciation for the business environment in which the organisation, its technical resources, and its people, were to be developed. This resulted in a degree of confusion, conflict, misunderstanding and overlap. For example, two different benchmarking missions were undertaken by two different teams at international locations to evaluate a particular technology. One mission evaluated business benefits, the other, organisational impacts. The team evaluating business benefits concluded that the technology was appropriate but the other team concluded that the technology was inappropriate. This split team approach resulted in unnecessary project delays and “turf wars” between participants as no one possessed the balanced insights necessary to fully evaluate the technology.

The advantages associated with the effective integration of these processes was noted at Pacific Dunlop Bedding. They found that not only did this integration build management understanding and commitment, particularly into the change process, but it also helped ensure that the change process was perceived as an ongoing activity, that is, an activity that does not have a finite end and requires ongoing adjustment and allocation of resources.

5.3.3 Issue No 3. The degree of connection between business objectives and change goals

In some firms the processes for developing and reviewing manufacturing and change plans were integrated but the outcomes were not. Put differently the connection between investments in AMT, JIT, TQM and various organisational and human resource practices and business objectives and goals was not clear. This problem was apparent at Murray Goulburn Co-operative where a senior manager remarked:

"We needed to reduce our level of investment in Best Practices and concentrate on those things that directly added value to our bottom line. I think that we concentrated too much on things that were nice to have and too little on what we really needed to manage this business."

This lack of connectedness also exacerbated the difficulty that some firms faced in evaluating technological investments, particularly those involving the commitment of significant capital and resources. As noted by an R & D manager:

"We all know how difficult it is to quantify the benefits of AMT, particularly when projects are complex, involve large financial commitments and take a long time. Often it
comes down to sound judgement and "gut feel". We see the capital appropriation as really a PR document…it has to be couched in the right terms. Personally, I understand the difficulties managers face in evaluating these things and why they want to have arm's length dealings with them. It would really help if our strategy spelt out in more detail those technologies that we want and those we don't want and our planning process gave us an opportunity for these guys to get to know us."

In some firms, strategic goals had been articulated in a form that clearly defined the required set of capabilities and characteristics that the organisation needed and had been signed off by senior managers. Many employees also expressed the need for information that relates investments and practices to improved performance and which was packaged in a form that could be used to assist in "selling" change programs. The manager of Du Pont’s change process believed that their success was largely a result of linking certain organisational and human resource investments to improvements in business performance:

"It's not rocket science. You've got to have the right industrial relations reforms to be able to even get a foot in the door. Then you have to educate your people as to why they've got to change and organise and skill them in the right way. But this only unlocks potential. You've then got to have quality management to make the connection to customer needs, planning and measurement systems to make the connection to business needs and the right remuneration systems to give people incentive. If you have some luck and get some quick runs on the board that make a difference to the business, then it helps to keep the cynics at bay."

5.3.4 Issue No 4. Degree of connection between key decisions and the change plan

Some middle managers indicated that strategic plans failed to provide an adequate degree of focus as they didn’t generate a set of mutually consistent guidelines or provide a clear framework within which to make the day-to-day decisions that are integral part of their jobs. This issue is well expressed by a supervisor at Edgell Bird’s Eye in respect to the decision to outsource all maintenance activity on a complex DCS controlled manufacturing plant:

"We’ve spent almost A$40M on this new technology which certainly improves our quality and reduces our costs but it requires higher skilled operators and support staff to run it. We’ve just outsourced all our maintenance activity to an external contractor because we needed to reduce our fixed costs. Although the contractor is enthusiastic, he doesn’t have any of the skills, knowledge or experience needed on this equipment. If I’d just bought a Ferrari I wouldn’t have it serviced by an apprentice."
The general implication of this issue is that it can send conflicting messages to employees during a period of change which can fuel cynicism and increase stress and resistance.

5.3.5 Issue No 5. The design of the change process.

The change process at some sites (eg. EBE, Pampas, Don, Exicom) followed a prescriptive format with minimal, if any, consideration of the specific issues confronting that site. This was largely a result of many firms engaging management consultants who were unfamiliar with their site’s operations in some, or all elements, of their change programs. As a consequence many difficulties arose during the change process due to the different circumstances and issues that confronted each site. This resulted in additional cost and time and diffusion of effort. As remarked by the change champion at Edgell Bird’s Eye:

“The change process we used was supplied as a package from a consultant. It didn’t really fit as each of our sites were in a different state of development and had different needs. For example Bathurst wanted to have team structures before the corn season...by following the structured methodology we ran out of time and had to compress 40 hours of training into a day and a half. Manly has high seasonal labour requirements: for three months a year the workforce swells to more than double its normal size. We attempted to introduce teams during one of these periods and couldn’t get enough full time employees in the teams to make them work properly without having too few available to assist the contract employees in the plant. At Ulverstone we had decided to inject A$26M into upgrading plant and equipment. This meant that management were unable to provide the time and effort to adequately resource climate setting and other exercises and the change process stalled. We should have done some form of needs analysis on each site before we started...you need to know what the disease is before you can prescribe a cure for it.”

5.4 The Actual Change Process

As expected, the different drivers for change, change environments and planning practices observed had a substantial impact on the change process at each of the 12 sites. Variations were noted in terms of what interventions and practices were used and in what sequence, who was involved and why and how they were involved. Consequently it is not possible to extract generic aspects of the implementation process and illustrate them through the various case studies. We have therefore selected the unit of analysis as an operating site
rather than a particular implementation activity. It is clearly impractical (and inefficient) to describe all 12 cases and some criteria need to be developed to decide which cases to describe in detail. The remaining cases can then be used to enrich aspects of these discussions. In the preceding sections we have described some of these criteria in the form of contextual and planning issues that impact on firm's change activities. Drawing on these insights, we have developed the following criteria:

- cases which provide the greatest opportunity for learning about the implementation and value of AMT, JIT, TQM and Best Practices.
- cases which illustrate the impact of the differing rationale for change, in particular, survival versus improved performance or growth
- cases which illustrate the impact of differing change environments, in particular the issues of retrenchment, resistance to change and personnel changes
- cases which illustrate the impact of differing planning environments: in particular the level of employee understanding and acceptance of business direction the degree of integration between the manufacturing strategy and the organisational change process.

Three cases will be described: Kellogg, South Pacific Tyres and Fibremakers.

The Kellogg case involves the use of AMT, JIT and TQM in a highly structured and complex change process aimed at developing the capabilities needed to grow in the Asian marketplace. Gaining employee understanding of the need for change and overcoming resistance to change were key issues and as discussed earlier, the change process was an integral part of the manufacturing plan. This case also provides a good example of how collaborative supplier relationships can produce substantial improvements.

Fibremakers made extensive use of TQM and JIT to introduce a stream of improvements that reduced cost by A$2.0M/month, enabled the organisation to achieve "cost neutral" status and gave the firm a chance to survive. Key issues include personnel changes, large scale retrenchments and gaining employee understanding of business direction. The manufacturing plan is also, by necessity, a directional rather than detailed document and therefore the connections to the change plan are fluid.

The South Pacific Tyres case provides an opportunity to examine a technologically driven change process within a manufacturing organisation that is seeking to make significant improvements in costs, flexibility and quality. Overcoming the threats posed by the introduction of new technology (eg. change, downsizing, job complexity) and gaining employee understanding of business direction, particularly for those staff whose work was not directly affected by this technology, provided key learning opportunities.

Table 5.5 lists the change activities undertaken at all sites. All change processes involved TQM, benchmarking, and training and all except Smorgons, were involved in the
### Elements of the Change Process at Each Site

<table>
<thead>
<tr>
<th></th>
<th>AMT</th>
<th>JIT</th>
<th>TQM</th>
<th>CHANGE</th>
<th>BENCHMARKING</th>
<th>HR MANAGEMENT</th>
<th>LEADERSHIP</th>
<th>PLANNING</th>
<th>TEAMS</th>
<th>TRAINING</th>
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<tbody>
<tr>
<td><strong>FIBREMakers</strong></td>
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<td><strong>DU PONT</strong></td>
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<td><strong>AUSTRALIAN NEWSPRINT MILLS</strong></td>
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<td><strong>PAMPAS</strong></td>
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<td><strong>PACIFIC DUNLOP BEDDING</strong></td>
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<td><strong>DON SMALLGOODS</strong></td>
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Blank spaces denote elements not used at a particular site.
implementation of teams. The processes at 9 sites involved differing areas of AMT. Six sites implemented JIT and all of these also implemented AMT and TQM. Significant variation can be observed in the emphasis placed on overcoming resistance to change and investment in HRM, leadership and planning practices. As noted earlier, all 12 firms possessed strategic plans and used formal planning processes prior to the implementation of the change process. Those firms identified as implementing planning as part of their change process were either adding value to the content of their existing plan (performing competitor analysis, market analysis etc) or adding value to their planning processes (involving suppliers and customers, integrating divisional plans etc).

5.4.1 Case No 1. Kellogg

5.4.1.1 Consultative Committee

Table 5.6 lists the major events in Kellogg’s change process. In March 1988 Kellogg appointed a senior manager to oversee this process. This manager directly reported to the Manufacturing Manager and was allocated 2 full time staff to assist in the implementation of the change program. One of the first tasks undertaken by this manager, henceforth referred to as the change champion, was the formation of a joint management/employee consultative committee. This committee was in broad terms, to be made responsible for all aspects of the change process that impacted on employee performance; in particular, job design, work process development, skills development and award restructuring. Significant variation was noted in the responsibilities accorded to consultative committees which appeared to be a major factor in assessing their effectiveness as a collective change body. For example Edgell Bird’s Eye and Pampas’ consultative committees were given limited authority and these were the only two committees were inactive for periods of the change process.

Kellogg’s consultative committee was subsequently formed in June 1988 and consisted of 12 members, 5 management representatives and 7 union representatives. Kellogg believed that biasing the composition of this committee was significant in gaining workforce commitment to the change process. Other firms have taken a different approach. Fibremaker’s consultative committee consisted of 5 management representatives and 7 union representatives reflecting the greater degree of managerial control over the change process at that site. Australian Newsprint and Smorgons committees’ consisted of 6 management and 6 union representatives with a high degree of decision making authority given to the group. Exicom took a different approach. Their committee consisted of 5 management and 5 union representatives and 2 other employees not involved in the manufacturing function.

At Kellogg, each member of the consultative committee completed specific training to enable them to participate constructively. Meetings were generally externally facilitated.
<table>
<thead>
<tr>
<th>Date Range</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>January 1988</td>
<td>Launch ACSP</td>
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<tr>
<td>March 1988</td>
<td>Appoint change champion form consultative committee</td>
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<tr>
<td>June 1988</td>
<td>A$400M capital expenditure approved</td>
</tr>
<tr>
<td>October 1988</td>
<td>Benchmarking by consultative committee</td>
</tr>
<tr>
<td>December 1988-</td>
<td>Management presentations to collective workforce: company direction and rationale</td>
</tr>
<tr>
<td>February 1989</td>
<td>for change</td>
</tr>
<tr>
<td>August 1989</td>
<td>Consultative committee presentations to small groups; company direction, rationale</td>
</tr>
<tr>
<td></td>
<td>for change and award settlement</td>
</tr>
<tr>
<td>September 1989</td>
<td>Job security / employee redeployment agreement</td>
</tr>
<tr>
<td>October 1989</td>
<td>Site agreement introduced</td>
</tr>
<tr>
<td>November 1989</td>
<td>Workforce english / numeracy literacy program commenced</td>
</tr>
<tr>
<td>December 1990</td>
<td>First AMT installation commissioned</td>
</tr>
<tr>
<td>January 1991</td>
<td>Incorporate TQM in work team project</td>
</tr>
<tr>
<td>June 1991</td>
<td>Introduce first work team</td>
</tr>
<tr>
<td>June 1991- July</td>
<td>Job redesign (STS Process)</td>
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<tr>
<td>January 1992 -</td>
<td>Implement supplier JIT program</td>
</tr>
<tr>
<td>April 1994</td>
<td>Progressive implementation of HR systems</td>
</tr>
<tr>
<td>August 1993 -</td>
<td>Leadership Training</td>
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<td>February 1995</td>
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Training included barriers to learning, restructuring, negotiation and conflict resolution, problem solving, conducting meetings, group activities, communications, action planning etc. As remarked by the change champion:

"It was a real culture shock for a lot of people when we formed this committee and it took a lot of hard work to get it off the ground. It was implemented after a messy award negotiation and many of the same people were involved. Talking negotiation one day and collaboration the next just doesn't happen. We spent a lot of time getting to understand each other, developing ground-rules to work with and getting union organisers involved who had experience with these things. We also needed to lift the status of the committee and start talking to the broader workforce so we did some benchmarking visits."

5.4.1.2 Benchmarking

During the last quarter of 1988, benchmarking visits to 10 different firms were conducted by the consultative committee. The objectives of the visits were to improve understanding of Best Practices and gain an appreciation for the issues and barriers that were encountered in their implementation. The findings were subsequently analysed and through small group discussions, fed back to the broader workforce. As remarked by an employee:

"I think the sessions were a good idea to get people thinking and for us to hear their reactions to things such as collective agreements, rationalisation of job classifications and possible layoffs through AMT introduction, but we created a real expectation. People were expecting change virtually tomorrow and we were talking 3 years off.

All 12 firms undertook some form of benchmarking activity at some stage during their change process. For example at Australian Newsprint Mills and Pacific Dunlop Bedding, a cross section of employees were involved in initial benchmarking missions to identify performance gaps and involve employees in the change process. At Pampas and South Pacific Tyres operators were involved in initial benchmarking activities to help define the scope of the change process. These individuals later presented the results of the activity back to the broader workforce. Other sites, for example, Exicom and Du Pont initially performed international benchmarking activities using the entire consultative committee. Here benchmarking served as a hybrid team building and information gathering process. Many firms, for example Kellogg, South Pacific Tyres, Smorgons, Du Pont and Exicom subsequently used process benchmarking extensively during the change program to institutionalise a measurement culture, identify improvement opportunities and quantify the magnitude of the improvements

227
made. The extent of benchmarking activity that occurred within the 12 firms studied is also due, in part, to the awarding of Best Practice grant. A number of firms indicated that they applied for a grant in order to undertake international benchmarking missions as the expenditures associated with this work were extremely difficult to justify within their existing site culture.

5.4.1.3 Management Presentation

The feedback from these meetings was compiled and a decision taken to have the management team conduct presentations with staff to communicate why Kellogg needed to change, where they were headed, the pivotal role of employees in the change process and to respond to the earlier issues and concerns raised. These discussions took place during December 1988 through February 1989:

"We closed the place down and took all 600 people off site to the RSL for a series of presentations by the management team. We talked about the big picture of business... what the successful companies were doing, what we were doing, why we were going to invest $600M in our operation, and why we needed to change... it was a disaster."

Kellogg management had high expectations of this session, expecting individuals to generally understand and relate to the need to become internationally competitive and to be prepared to partake in the process. However many employees:

- failed to comprehend the message due to language barriers (47 different nationalities represented with 50 different languages spoken on site),
- failed to understand the message as it wasn't expressed in a form that they could directly relate to. "It talked about business issues rather than things that affect the shop floor."
- understood the message but could see no reason to change as the company was still returning good profits.
- understood the message and wanted money up front to share in the anticipated company rewards.
- used the meeting as an opportunity to strengthen their negotiating position as award restructuring activities were occurring at around this time.

As remarked by the change champion

"We learned first hand just how much misunderstanding and resistance we had to deal with and did a number of things before we went too far. First, we needed to put our message in the language of the people and be able to reach people on a more personal level. Second, we needed to get some ownership into the process: we needed to
involve “their” consultative committee. Third, we needed to give them something to think about that made the presentations an event they’d remember, and forth, we needed to urgently introduce English literacy programs into the workforce. In hindsight this meeting was, in my opinion, the single most important event in our entire change process.”

In August 1989 the message was put to the workforce but in a different form:

- it was a joint management/union presentation from representatives of the consultative committee.
- the sessions addressed no more than fifteen people at a time.
- a three part video was produced to enhance the presentations and support their new communication philosophy.
- every individual was given a copy of a video presentation to take home. The majority of individuals who couldn’t speak English had English speaking children who could interpret for them if necessary.
- award restructuring was discussed, and the company put forward a proposal for all employees to consider.
- an educational program to improve English literacy was announced.

The sessions were highly successful, improving workforce understanding of where the firms was headed, gaining some commitments from employees to change and cementing the role of the consultative committee in the change process. This view was strongly supported by many other sites. Du Pont believed that it was imperative that the change process is managed by the consultative committee to ensure that it is credible, relevant and accepted by the workforce. Smorgon’s believe that, although their change process faltered somewhat when the change champion departed, the impact would have been substantially worse if the consultative committee had not developed the same degree of ownership over the process. Conversely, Murray Goulburn’s change process was redesigned and reprioritised with a change in key personnel as there was insufficient buy in to the original change plan and change process by the consultative committee and therefore the broader organisation.

A single site agreement was subsequently reached at Kellogg during October 1989 and the process of removal of demarcations commenced. A detailed change plan was jointly prepared by representatives of the management team and consultative committee to guide the change process over the next 10 year period. A number of key aspects of this program will now be discussed:
The first two phases of Kellogg's ACSP involved A$600M investment in new plant and technology and made considerable use of AMT's. The first stage of investment involved the allocation of A$400M for specialised and highly computerised production equipment (FMS) and packaging equipment to meet emerging capacity, flexibility and quality requirements. The second phase involved the commitment of A$200M for an automated bulk silo facility, a computer controlled multi-product food processing line (FMS), a new direct feed computer controlled conveyancing system, three new packing lines and new computer controls for 3 existing boilers. In respect to the strategic value of this investment the CEO remarked:

"10 years ago we produced 8 different cereals. Today we produce over 20 and when our strategic plan is fully implemented we will produce in excess of 40 different cereals with about 10 of these having 3 or 4 different product mixes. High volume flexible operations are becoming the name of the game and with it is our relentless drive to compress processing time and improve quality. But it's important to understand how we view technology in this process. In this business most firms are using the same technology, sure there may be a first mover advantage here or there, but it doesn't give you lasting competitive advantage. We believe that you need current technology in order to compete but your people are what differentiate you from the rest. Our strategic plan is based on the premise that you use technology as an opportunity to change the way you organise people, to increase their responsibility and understanding and to break out of the old ways of the past. It's like the key that unlocks the door to Best Practice."

This view of technology was supported by many other firms including Du Pont and Edgell Bird's Eye. Du Pont view technology as an enabler, rather than qualifier, of best practice. They view technology, like quality and safety, as one of the systems that are needed to create the work environment that facilitates competitive advantage through people. Edgell Birds Eye's A$39M investment in potato processing technology was justified on the basis of changes in site culture through an accompanying set of adjustments to organisational systems and human resources and improvements in product quality and workforce efficiency and productivity.

Kellogg's CEO's philosophy is reflected in the effort that Kellogg has expended in the implementation of AMT. First, Kellogg do not believe that people improvements can be leveraged from AMT if employees are threatened by technology. Consequently, through the consultative committee Kellogg has developed job security and employee redeployment
agreements. Kellogg has assured all personnel in writing that no individual will be retrenched as a consequence of the introduction of AMT. It is noteworthy that staff attrition rates average 5% p.a. at Kellogg and therefore a natural mechanism exists to reduce staff strength if necessary. Second, individuals either unable or unprepared to operate new plant and technology will be redeployed into other work areas. It is also noteworthy that average staff age is 33 with less than 20% of operators in excess of 45 years of age. Kellogg therefore do not have to contend with a large ageing workforce that may not be prepared to make the additional personal investment in acquiring new skills and knowledge.

All AMT projects are headed by a project leader and introduced by a project team using a comprehensive and highly structured implementation plan. A member of this team attends each meeting of the Consultative Committee to report back on project progress.

New technology has been incrementally introduced since December 1990. Post mortems are conducted after each new project is completed and learnings are extracted and fed back to the workforce via the consultative committee. A member of the consultative committee remarked:

“The post mortem sessions have proved really useful. The operators involved in each project actually run them and talk of their experiences - good and bad. Some of these operators are now "gurus" for technological change. By involving other people like this we are able to spread the workload and help make sure that we’re not seen as some sort of elitist group.

5.4.1.5 TQM

Quality had been given a high priority since the beginning of W.K. Kellogg’s Toasted Cornflake Company. The company’s motto “we are a company of dedicated people making quality products for a healthier world”, underlies this commitment. When comparisons to international affiliates however indicated that quality measures were poor by comparison, Kellogg Australia embarked on a large scale program to improve quality. As remarked by the CEO:

“We knew that Asian markets were highly sensitive to product quality and delivery assurance and that, in relative terms, our performance in these areas was not good. We also knew that our parent company in the US would not support our capital development program unless quality improved markedly so we invested a lot of resources learning about quality and how to improve it and then doing something about it.”
Kellogg embrace the Quality Criteria used in the Baldridge Award which place significant emphasis on customer focus and customer satisfaction. Consequently, Kellogg’s have invested considerable time evaluating market reaction to their products, developing product and service standards and soliciting ideas for improvement. As the process for continuous improvement was based on collaborative problem solving and strengthening Quality as a core organisational value, Kellogg wanted to involve as much of the workforce as possible in the quality improvement process. Responsibility for quality was assigned to a senior manager who worked closely with the Consultative Committee to ensure that overlaps were eliminated and all actions were consistent. Specific activities undertaken included:

- the development of customer service standards
- the identification of core areas for improvement
- the development of quality improvement strategies
- the development of training programs in process analysis and problem solving
- the development of detailed sets of quality measures

It is noteworthy that Du Pont, Edgell Birds Eye, South Pacific Tyres and Pacific Dunlop Bedding similarly apply the Baldridge criteria in prioritising and planning improvement activities. Some firms, eg. Pampas, Du Pont and Pacific Dunlop Bedding have also either applied for, or are in the process of applying for, an Australian Quality Award.

A key responsibility of Kellogg’s Consultative Committee was the development of autonomous work teams, a decision was taken in January 1991 to implement these activities as part of the team development project (a project previously agreed as part of an award settlement) rather than as a separate initiative.

"By not introducing quality as a separate initiative we helped to ensure that people did not get confused. There were real overlaps between our team development process and Quality Improvement Process (QIP) and it was important to recognise them and manage them early. Also, during this time our overtime level was averaging about 30% due to high product demand and operator training on new equipment was about to start. We would have had a resource crisis if we'd implemented QIP at that time."

Another member of the Consultative Committee commented:

"It was important to have one voice to the people. We all knew that major changes were needed in the area of quality and all employees associated this committee with workplace change. At this time things were really "fragile" and it was really important that we had ‘all bits of the change process in one basket and managed that basket carefully.'"
5.4.1.6 JIT

Time is a key organisational value at Kellogg and the change champion spent significant effort evaluating aspects of JIT to see where they might be of value. JIT was found to overlap considerably with many of the other change activities occurring at the time. The considerable overlap between JIT and other improvement activities was also noted at Fibremakers, Du Pont, Edgell Birds Eye and Smorgons. At these sites JIT activity tended to apply those practices that focus on improvements in customer supply processes and materials specification and storage rather than on those practices that directly effect production. Kellogg had earlier undertaken a process mapping exercise and identified a number of areas where excessive time was taken and developed some capital expenditure requests to have them addressed. Land is extremely expensive around this site, and consequently facilities had developed vertically, rather than horizontally, over the years. Facilities were spread over 5 floors and application of JIT tools and techniques enabled Kellogg to identify and eliminate a number of material movement problems.

Some aspects of JIT also weren't applicable as processing lines were generally dedicated to particular products and therefore line changeover wasn't an issue. Site facilities were also already set up around manufacturing cells. Kellogg believed that the largest benefits from JIT would be associated with improvements in materials and materials supply systems and therefore developed collaborative work teams with suppliers. It is noteworthy that Kellogg's labour costs were less than 10% of total production costs and consequently productivity and efficiency improvements yielded relatively small gains. Material costs however remained approximately 50% of total production costs and there were many areas where the need for improvement was acknowledged. As remarked by the Materials manager:

"I clearly remember when I first came into this job how the logic used to go ... A production problem would arise and almost invariably someone would say.. it's a materials problem. I'd respond by saying surely the material received was tested to specification so why isn't it acceptable? Assuming the material is to specification and there's still a problem, is there something wrong with the specification, method of testing, method of transportation, storage etc, or perhaps method of manufacture? By getting people to start to ask all these sorts of questions we started to realise that there was a lot we didn't know about our materials.... this was going to become even more important to us when we exported to Asia due to the more stringent product quality requirements. This meant less tolerance in the process and that meant less tolerance to materials variation."
JIT activity was not co-ordinated through the Consultative Committee as the changes introduced did not substantially impact on employees job roles and skills. Two major projects were subsequently undertaken over the period March 1992 - April 1994: one with the packaging supplier and the other with the sultanas supplier.

Kellogg had historically purchased packaging material on the basis of customer reputation and product quality, reliability and cost. However, they hadn't developed an understanding of the important characteristics of the material that determine how well it ran through the packaging line. When a new product was introduced there was an ongoing problem with obtaining consistent colour on the product boxes. Kellogg's convened a meeting of all affected parties: board manufacturer, ink maker, carton maker, Kellogg packaging equipment engineers and advertising personnel (aesthetic packaging requirements). Each party had a different perspective on the problem. Understanding the whole problem, the critical issues, the core requirements of each group and what each group could, and could not accept was critical to problem resolution. Compromises were eventually reached and the final solution required less material and less steps to manufacture. Savings are estimated in excess of A$1.0M/annum.

The second project involved sultana packaging. All Kellogg's sultanas were supplied in 14kg boxes, the international standard. It was considered that if sultanas were stacked in larger boxes they would combine to form "a block" unsuitable for processing. As Kellogg processes 2500 tons of sultanas per annum, the wastage in packaging and handling was significant. Kellogg initiated a joint venture with Sunbeam, the sultana manufacturer to develop an option to use 1 ton bulk containers. These containers were successfully trialed and bulk handling equipment installed at Kellogg's facilities. It is estimated that the change from 14kg boxes to 1 ton bulk handling facilities will also result in savings in excess of $1M/p.a.

A shop floor employee remarked:

"These activities are as much about solving a problem as developing a long term relationship...they spawn improvements in other areas. For example we're now working with seed breeders, growers, millers and government departments to develop seed characteristics that optimise the growers yield (maximise farmer's return per hectare), millers yield (maximise miller's return per kg of product milled), and cooking yield (maximise Kellogg's RTE serial yield per kg of grain used).”

5.4.1.7 Establishment Of Work Organisation Teams

A key responsibility of the Consultative Committee was to ensure that the social systems of work "fit" with respect to the new technology and emerging business requirements. Highly participative socio-technical forms of work design have been implemented, to some
degree, at all 12 sites. Most sites reported that this process not only produced a better result but also provided a unique opportunity, through the social analysis to gain a better understanding of employees attitudes towards work, change and the organisation generally. In many instances this process spawned additional activities. For example, at Australian Newsprint Mills it generated a specification for an information support system and at Don the process initiated the development of the site's Equal Opportunity Policy.

In order to decide the best way to organise resources and work at Kellogg, eight different job design activities were undertaken by eight different teams during the period June 1991 through July 1993. New workplace models were subsequently developed that incorporate the:

- strategic imperatives of continuous improvement in cost, quality and flexibility,
- new technologies to be introduced
- concepts of empowerment, teams, measurement, delegation of responsibility, career paths, multiskilling and flexibility.

These workplace models were, with minimal amendment, approved by the Consultative Committee and subsequently communicated to the broader workforce for understanding and comment. As remarked by a member of the Consultative Committee:

"The job design feedback went really well. They were detailed documents that laid out in a lot of detail what the place was going to look like. ...defining roles, category structures, progression systems, support systems and arrangements and including some general statements about values and behaviour. It was the first time people could really get a feeling for what this new technology was going to mean to them. We also had a fair bit of time until the technology was commissioned so we could change things if we needed."

From the benchmarking visits conducted, the Consultative Committee were aware that the introduction of a team based organisation can pose significant threats to employees, line managers and team leaders. To facilitate the change process it was decided to trial the introduction of teams in one area (corn/bran) in June 1991 and:

- give team members appropriate hard and soft skills, including TQM
- give team members exposure to high performing teams in other companies,
- develop a new style of supervisory behaviour ("boundary rider"),
- set clear and well understood sets of measures and goals to assess team progress.
Work teams however, were not implemented without significant difficulty. First, although an enterprise agreement was in place since 1989, a number of demarcation issues were unresolved, resulting in conflicts between team members and management frustration. Second, the appropriate set of human resource policies (career progression, remuneration, measurement and reporting systems, training needs analysis, employee review, team review) were not in place and therefore it was difficult to sustain the type of team behaviours that Kellogg were attempting to introduce. Third, many difficulties remained in the area of English literacy and many teams were finding internal communication extremely difficult. Fourth, many employees considered the training to be irrelevant and esoteric. As remarked by an employee:

"...at that time we needed grass roots training on how to handle day to day matters, things like getting materials, organising contractors, setting priorities, entering information in the computer etc, not high level, ideological, team building stuff."

Fifth, many employees considered that too many changes were introduced too fast, resulting in stress and a number of people being left behind. This claim is partly supported by a relatively high level of safety incidents and absenteeism observed over the period 1991 to 1994. Finally, despite extensive efforts by the consultative committee, it was extremely difficult to keep all employees informed due to shift commitments, involvement of personnel in other change activities and a high level of overtime. Communication was replaced in some areas by information dissemination (newsletters etc) and as a consequence, employee commitment and understanding was adversely effected. As a consequence of these difficulties a number of members of short term actions were taken including the assignment of some members of the Consultative committee to teams during 1992 - 1994 to offer support in the following areas:

- coach the development of team skills and behaviours
- build confidence and trust in team members
- develop and investigate new methods to help teams to achieve goals
- encourage different viewpoints, debate and openness within teams
- assist in identifying long term training requirements
- train team members in problem solving, performance measurement etc
- assist with the induction of new personnel to the team

Two major longer term actions were also initiated; the development of leadership capabilities and the development of Human Resource Systems.
5.4.1.8 Leadership

Within Kellogg, the pursuit of Best Practice is largely dependent upon the development of leadership capability. Although a line responsibility of the human resource management function, leadership development within Kellogg has made extensive use of the consultative committee as a resource to shape the company's leadership development program. Kellogg's leadership model encourages managers to develop and apply leadership skills that create a work environment conducive to team progression. Team members are encouraged to develop and practice leadership to accelerate the development of teamwork and identify and explore creative and innovative improvement opportunities. As remarked by a middle manager:

"we were trying to get managers to empower teams so that they can manage their own core work processes and the teams develop the skills and knowledge required to become self-managing."

Kellogg approach leadership from a practical aspect emphasising experiential learning. Kellogg's leadership training is based upon John Adair's "Action Centred Leadership" and Kenneth Blanchard's "Situational Leadership models. Each employee has received a minimum of 18 days leadership training during the period August 1993 through February 1995. Each course involves all members of one particular work group with six, three day sessions conducted over a 12 month period. Each session generates outcomes that can be taken back to the workplace, acted upon and reviewed at the next session. As remarked by the training manager:

"Our focus is on the practical aspects of developing leaders and high performing teams. We believe we know what works and what doesn't since we have lived through it many times. If you can't take something back to the workplace to be applied and reviewed then you might as well forget it."

In order to ensure that skills learned are skills applied, Kellogg has tried to develop a workplace environment conducive to the acceptance and development of leadership capabilities. Consequently, the board of directors and senior management attend the initial course and subsequent courses involve lower organisational levels with a view to cascading the desired leadership environment down the organisation. In addition, participants received a copy of the course video, self development reference books, aide memoire cards and "T" shirts for leisure time reminders. As remarked by the CEO:

"we're still coming to terms with leadership: At first many managers thought it just meant what they were already doing; providing direction and support, encouraging trust and involvement, breaking down barriers - things you'd just regard as part of doing your
job properly. But with magnitude and speed of change activity occurring, they also realised how much more was involved in getting all employees to share our vision and want to buy in to it. As for the teams I think that many of them really got a lot out of the leadership training. The way we conducted the training it was as much about team building as it was about leadership."

5.4.1.9 Human Resource Systems

Much of the initial change activity had focussed on high level strategic issues and low level workplace reform. Many of the intermediate activities that link changes at the shop floor to emerging business requirements (key result areas, objectives, targets and measures) had not been introduced. Further, through subsequent benchmarking visits to other Best Practice sites, representatives of the Consultative Committee had recognised these systems as critical to sustaining performance improvement.

"At other sites people often advised us that things often start off with a wave of enthusiasm but it seems to decay after a couple of years and the program loses momentum. The really successful sites had reward systems that encouraged the behaviours that they were seeking, appraisal processes based on 360 degree feedback, team performance measures and targets that were linked to business needs...all the sort of things we knew we should have but didn’t.”

These observations were also consistent with the experiences of some other firms. Pampas found that a high staff turnover rate and ineffective recruitment policies were substantially impacting on its ability to develop teams. Du Pont and Pacific Dunlop Bedding found that they needed to modify employee reward systems to maintain their continuous improvement capability. Australian Newsprint Mills founded that it needed to develop effective HR technologies to progress teams through the various stages of development: forming, storming, norming and performing (Tuckman, 1965). For example, in the early stages of team development emphasis was placed on the development of basic technical and interpersonal skills (eg. communications) and the clarification of roles and team goals. As the team developed more effort was placed in the development of additional interpersonal skills eg. giving and receiving feedback, conflict resolution, management of difference etc and business skills such as setting budgets, monitoring performance, managing contracts etc. Australian Newsprint Mills believe that their ability to develop teams effectively is largely a result of a self paced evolutionary approach that empowers teams in stages and supports each stage with an effective training process.
Kellogg's Human Resource Manager and his staff introduced Human Resource Systems using proven technology sourced from Kellogg's international affiliates and consultants during the period July 1993 onwards. Systems were still being introduced when the case study was conducted (December 1994). These technologies have been applied to develop systems which include: the recruitment of staff, professional development (needs analysis and training), team and individual appraisal, team and individual rewards, key result areas, performance benchmarks, key stakeholder analysis, evaluation of change processes, management of critical success factors and linking business needs to individual skills and competencies. The Human Resource manager remarked:

"We saw the Human Resource System as the mortar that held all the bricks in our change process together. As such we needed to make sure that the systems we developed fitted with our culture and unique site history and were appropriate for our stage of development. Therefore my involvement with the site consultative committee proved invaluable as it gave us an opportunity to test the water and communicate all major changes to the workforce."

However, Kellogg found that the introduction of Human Resource systems can also cause a number of concerns. First, some employees indicated that they believed the remuneration systems were encouraging individual performance rather than team performance. Second, others considered the staff review process too subjective and difficult to manage and lacking in credibility. Kellogg are addressing this issue by providing those that perform staff reviews additional training. Third, a number of award stumbling blocks had been encountered for some trade classifications. Consequently, although all employees were structured in teams, differing classification and progression criteria existed for some of the employees within the teams. This not only resulted in limitations and conflicts but also meant that it was extremely difficult to effectively introduce Human Resource systems that support the new way of working when site practice is a hybrid of the old and new way of working. As remarked by a group leader:

"We have to sort out these inconsistencies quickly as they're a real risk to teamwork development. Some guys are paid for overtime - others aren't. Base rates of pay differ by up to 15% even though we're now all doing similar types of work. Some of us get staff reviews and some don't. Some of us have also been slotted into new category structures and given yearly performance objectives and others haven't. It's a real mess."
In summary, although many issues were yet to be resolved, by the end of 1994, Kellogg had successfully introduced and sustained a considerable number of interventions and practices and gained the commitment of a critical mass of employees to both its ACSP and its change strategy.

5.4.2 Case No 2: Fibremakers

Table 5.7 provides a list of the major events in Fibremaker's change process. In June 1990, as part of its Asia Pacific expansion program, Du Pont purchased Fibremakers Synthetic Fibres Operations. For the previous financial year, Fibremakers operations:

- lost an average A$2.5M per month,
- experienced 8 major industrial disputes,
- had a labour turnover of 44%,
- demonstrated extremely poor occupational health and safety performance,
- provided minimal opportunities for employee progression and development.

Du Pont retrenched the local Fibremaker's management team and appointed 10 Du Pont secondees, principally American. In stark contrast to Kellogg the Management Team, rather than a joint committee of management and shop floor representatives would lead the change process. The Management Team developed a business plan for the Fibremakers operation that took a long term focus and was based on the establishment of a work culture of teamwork and co-operation. The plan was structured around 3 stages and based on an evolutionary and inductive, rather than prescriptive and forced, approach to change. That is, an approach based on the development of the skills and capabilities of personnel rather than an approach which defined and implemented systems and then trains staff to improve systems. Effort was to be focussed through the operations' value adding processes and it was envisaged that the implementation of this plan would create a "bridge to the future", enabling employees to see:

- where Du Pont Fibremakers, as a company, was headed,
- how their efforts could make a difference to the company's performance,
- how the quality of their working life could be improved.

The change process at Fibremakers was a high impact work restructuring and development program which targeted best practices and the achievement of a world class operation within an extremely short time frame. The three stages in Fibremakers change process were:
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<th>Month</th>
<th>Year</th>
<th>Event</th>
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| June 1990 |      | Fibremakers sold to Dupont  
|           |      | Strategic plan finalised  
|           |      | New management team appointed                                        |
| July 1990 |      | Operation closed for 3 weeks  
|           |      | Safety and business performance imperatives discussed                |
| August 1990 |  | Safety Management process launched                                    |
| September 1990 |  | 500 Retrenchments                                                     |
| November 1990 |  | Enterprise agreement  
|               |      | Progressive generation / implementation of improvement by workforce |
| November 1990 |  | Consultative committee formed                                          |
| January 1991 |  | Commenced benchmarking with other Dupont and Australian firms         |
| March 1992 |      | Organisation restructured                                              |
| April 1992  |      | Commenced the development of teams                                     |
| June 1992 |      | Product prices plummeted by up to 40%  
|           |      | Realisation that change process inappropriate  
|           |      | Evaluated SCM process (TQM / JIT Hybrid)                              |
| September 1992 |  | SCM Trialed                                                            |
| November 1992 |  | Project managers appointed for 3 major SCM projects (CFM, P & D, S & P) |
| December 1992 |  | Team project abandoned                                                  |
| January 1993 - December 1994 |  | SCM Projects implemented  
|               |      | (Teams formed, training provided, etc.)                                |
5.4.2.1 Stage 1 Communicating the need for change and developing relationships

Three weeks after acquisition, Du Pont closed down the operation for 11 days. This was used as an opportunity for the new management team and workforce to get to know each other and to discuss three key issues:

**Issue No 1 Safety.**

The new CEO indicated that Fibremaker's safety performance was totally unacceptable and discussed the linkage between safety performance, operational performance and business performance. He indicated that within successful Du Pont operations, the approach taken to Occupational Health and Safety (OHS) reflected a core value in the workplace. The CEO described the characteristics and behaviours of these firms and contrasted them to those at Fibremakers. Time was also taken to explain the methods, tools and techniques that Du Pont used to improve safety performance and demonstrate how they could be applied to improve performance in other areas of the operation. The CEO also indicated Du Pont's preparedness to invest significant resources to improve safety at a time when the business was continuing to lose A$2.5M/month. An employee remarked:
"I remember the session well. The hairs on the back of my neck stood out. It was a surprise to all of us - to have someone of that importance standing up and discussing safety before anything else. It was an indication of how seriously Du Pont took it all. By making some pretty big statements about where we'd be in 12 months they laid their credibility on the line."

In August 1990, Fibremakers launched a comprehensive safety improvement process with the objective of developing a Best Practice safety culture. The company believe that this initiative has greatly assisted in developing a continuous improvement capability and improving site performance in other areas. First, it was common ground between all employees (“no one wants to get injured”) and this helped to develop strong relationships and bonds at all organisational levels. Second, by making individuals accountable for their actions, it facilitated acceptance of responsibility and teamwork. Third, by providing a platform of tools, systems and methodologies (eg job standards, job planning, incident investigation and prevention, measurement, recognition and rewards, audits etc) and fostering collaborative problem solving approaches, it created a work system that could be applied to improve other areas of performance such as product quality and processing time. Fourth, the development of safety culture has been led “top down”. Through leading by example, the management team has not only obtained the commitment of employees to improve safety but also gained their trust and respect. Senior managers indicated that this had assisted their efforts to introduce transformational change.

The development and subsequent diffusion of site safety culture as a strategy to develop best practices is unique to Fibremakers and Du Pont. The Du Pont operation recognises safety as one of a number of planks that need to be in place to pursue and sustain Best Practice. Other firms studied, such as Smorgons, Don and Pacific Dunlop Bedding have comprehensive safety management processes but none either use them to drive best practice nor have effectively integrated them with their best practice initiative.

**Issue No 2: Business Performance - General**

The management team discussed the views and expectations of shareholders, customers, and the community with all employees. Significant time, effort and energy was also spent explaining the need to become internationally competitive and the role of employees in the improvement process. Employee's opinions were also solicited as to why the company was performing poorly and what actions could be taken to improve performance. Many problem areas and barriers to change were identified. Both management and employees made commitments about working toward a co-operative relationship and as a first step, agreed to form a consultative committee.
Activity No 3: Housekeeping

The new CEO indicated that he believed the condition site to be a reflection of the morale of the staff. All employees agreed to work to improve the workplace by painting, window cleaning, gardening, removing obsolete equipment etc. An employee stated:

"It doesn't sound much now but it was amazing how much difference it made to clean the place up. We'd all thought the site was going to close and no one had much pride in their work. We came away from these sessions believing that management really cared about our work conditions and our safety and that made us all a bit more determined to put in."

5.4.2.2 Stage 2. Activity 1. Enterprise Agreement

In November 1990, all site unions, award employees and management formed a single bargaining unit that essentially operated as an enterprise agreement. The initial agreement included specific commitments by all parties to significantly increase productivity and efficiency and to embrace the concept of continuous improvement. The CEO was actively involved in the development of this agreement and indicated to all employees that he could not commit to a redundancy agreement per se, and that retrenchments would in all probability continue to occur until the operation became profitable. As remarked by a shop floor employee:

"We all realised it was unrealistic to expect job guarantees to be given. Jobs were being lost in the industry everywhere. Management were very clear about it: unless we could do things better and with less people we weren't going to survive. Each time we introduced an improvement that saved labour we didn't see it as costing jobs but saving jobs."

During the next 12 months, 40 major demarcations and restrictive work practices were removed despite a significant number of retrenchments and widespread job security fears.

Eight of the twelve sites studied had completed an enterprise agreement and the content of these agreements varies substantially across firms depending on the prevailing site change environment, stage in the change process, union commitments etc. Australian Newsprint Mills considered the key outcomes to be union rationalisation, elimination of paid overtime and removal of demarcations. Pacific Dunlop Bedding's agreement enabled union rationalisation and introduced remuneration systems that incorporated pay for skills and pay for performance concepts. Pampas considered removal of demarcations, commitments to improve productivity and the introduction of 12 hour shifts as key outcomes. Smorgons indicated that union rationalisation, removal of demarcations and commitments to engage contractors for mundane or specialist work
were key outcomes. Du Pont was an example of an organisation that had made considerable progress toward best practice. They considered that their fourth and most recent enterprise agreement provided the following outcomes: a formalised commitment to pursue continuous improvement, a commitment to respond to emerging challenges and opportunities and committing to the principles of best practice.

5.4.2.3 Stage 2. Activity 2. Site consultative committee

The site consultative committee was formed in early 1991 and consisted of 6 employee representatives and 6 company representatives. The committee's core charter was "to provide a forum for employee and management representatives to meet and jointly consider business and employment issues, and to help employees to gain increased understanding of the basis for decisions made by the company."

As the committee included all senior management representatives, decisions could generally be made during the course of meetings. This "action oriented" status has served to give the committee credibility and build relationships between key stakeholders in the change process.

5.4.2.4 Stage 2 Activity 3. Retrenchments

Through attrition and forced redundancies, workforce strength has reduced from 900 to 500 during the period July 1990 to January 1995. In August 1990, 150 employees were retrenched with a further 100 retrenched in January 1991. As noted by a shop floor employee:

"Retrenchment is almost a way of life in the textile industry: It has been shrinking for some time and the fact is that there are more people than jobs. No one would dispute that. Those of us that have been through the last few years have seen some really tough times. Nobody likes retrenchment but we all know that there'd be even less jobs if it hadn't happened."

Clearly the industry environment assisted Fibremakers implement redundancies of this scale over this timeframe. However site management has also attempted to help employees understand why retrenchments have occurred by linking labour costs to business performance. As remarked by a senior manager:

"After safety, the first item on our consultative committee agenda was business performance. We have a very simple graph that shows fixed and variable costs and company profit or loss. Everyone could see how big the gap was between our current performance and break even. They could also see how improvements introduced in their work areas and retrenchments were closing this gap."
It is worthy of note that significant retrenchment, that is retrenchment of in excess of 10% of the workforce, occurred in 8 of the organisations studied and its impact on the change process varied significantly. For example at Smorgon's the involvement of state union officials elevated its significance to the workforce. At Edgell Bird's Eye's Bathurst plant in New South Wales, employees' alternative employment opportunities were poor and there was a general consensus amongst the workforce that the scale of redundancies was unnecessary. Consequently it had a devastating effect on the change process. At both Australian Newsprint Mills and Pacific Dunlop Bedding retrenchments had been occurring for over 10 years at an industry and at a site level. Consequently, employees viewed retrenchment as a way of life. At Exicom, alternative job prospects were extremely good and retrenchment therefore had minimal effect.

5.4.2.5 Stage 2 Activity 4. Organisational Restructuring

Feedback obtained from Stage 1 indicated that FibreMaker's organisation had a number of significant limitations which affected its performance. These included: poor communication, excessive bureaucracy, poor employee understanding of business and customer needs, little teamwork and mutual support, ineffective procedures, minimal feedback, ineffective and slow decision making and ineffective performance measures. The management team analysed organisational performance and developed a new structure that incorporated the following features:

- strategic business units (functional structures were disestablished),
- hybrid job roles (eg. plant management and engineering, plant manager and personnel),
- delayering (one level of middle management was removed),
- measurement (introducing simple sets of measures to guide improvement effort),
- information sharing mechanisms (newsletters, meetings, seminars etc).

All 12 firms have implemented SBU concepts to improve responsiveness to order and customer and business focus. However at four sites, concerns were raised that these operational and business outcomes might be obtained at the expense of core technical capabilities such as skills development and asset integrity.

Unlike many other organisations, Fibremakers opted for a low employee involvement redesign process as it was decided to focus on macro issues with micro issues such as teams, job classifications, category structures etc included in a consultative work redesign process in Stage 3. As noted by the CEO:
"We knew it wasn’t the ideal way to go about it but we needed to introduce a structure that delivered a workable framework quickly. Many people had left and there were gaping holes everywhere. We also needed to quickly develop a stronger customer and business focus.

5.4.2.6 Stage 2. Activity 5 Benchmarking

Resources were scarce and it was imperative that improvement effort was spent in the right areas. Initially there was little improvement focus and more improvement suggestions were being raised than the organisation had the capabilities to implement. As remarked by a senior manager:

“In the early days we had people going off in all directions. I think during the last 3 months of 1990 more than 200 improvement opportunities were identified. We didn’t have the money or the people to implement all of them and some people started to become disillusioned as their pet issue wasn’t being acted upon. They were also all good ideas that would save money and jobs. As we were about to move into another round of retrenchment we needed to act quickly in order to maintain people’s enthusiasm and credibility.”

Fibremakers had historically undertaken little measurement activity and initial efforts focused on safety, productivity and waste. The Fibremakers operation was benchmarked against similar international Du Pont operations during January 1991 and it was found that lost time injuries were 25 times higher than Best Practice, labour productivity was 45% (of Best Practice) and waste 300% (of Best Practice). Moreover the cost of labour at Fibremakers operations was approximately 50% of the net cost of converting polymer into yarn. Representatives of the consultative committee subsequently visited other Australian manufacturing firms to identify critical organisational improvement metrics. A set of 10 key measures was developed during the second quarter of 1991. These were lost time injuries, employee turnover, employee absenteeism, on-time delivery to customers, customer complaints, first pass yield, machine utilisation and efficiency, process labour, after tax operating income and cash flow. Graphs showing the performance of each business unit against each metric were prominently displayed and 10 shop floor focal points appointed to direct improvement effort in each area.
5.4.2.7 Deteriorating Business Environment

During 1991 the site's performance began to show significant improvement in many areas. However, by the middle of 1992 the domestic nylon and textile market deteriorated substantially due, principally, to the recession. Product prices fell by between 25 and 40% and it became obvious that the objectives articulated in the business plan were unattainable and the next stage of the change plan were inappropriate. Stage 3 focused on the evolutionary development of teams. The improvements that were expected from the implementation of team based operating structures would not yield the magnitude or rate of improvement that was needed to survive. As noted by the CEO:

"The business plan was prepared based upon projections of sales volumes, product prices and operating revenues. Plans to improve the performance of our manufacturing operations were subsequently developed based upon the extent and pace of reform needed to realise the objectives of the business. However, by the middle of 1992, the effects of the worldwide recession had placed enormous pressure back on the site as the prices of our products plummeted. We needed to fundamentally rethink what we were doing, where we were going and how we were going to survive."

Edgell Bird's Eye and Australian Newsprint Mills faced similar concerns. The business performance of both these firms deteriorated substantially during the early 1990's due to the effects of the recession, entry of new competitors into the marketplace and the ongoing reduction of protective tariffs. As a consequence, significant changes occurred to the change processes at each site and this had a detrimental effect on the outcomes achieved. The change champion at Edgell Bird's Eye remarked:

"When a New Zealand competitor took 15% of our market we knew we were in real trouble. At that time (1992) we were about half way through implementing our change process and we'd tinkered with everything...our culture, structure, systems, leadership style etc. When we were forced to abandon a lot of our change activities we knew that we were in real risk of losing it because we didn't have the ability to recover and go back to where we started...I don't think we've fully recovered yet."

5.4.2.8 Evaluation of Supply Chain Management

Fibremakers did not believe that there were significant additional gains to be made from pursuing another round of organisational restructuring. Although costs had shown improvement, in international terms, the site was still uncompetitive. Site management therefore knew that in order to survive the short term further retrenchments would need to
occur. Benchmarking activity had also indicated that despite the introduction of more than 200 different improvements, the performance of the nylon spinning and warpknit areas in particular, remained poor. Improvement effort was reviewed and it was decided that a more structured and systematic approach was required. Customers were now using imported yarns of superior quality and Fibremakers knew that its future success would also depend on its ability to improve product quality. A number of expatriate staff also commented on the large quantity of materials stocked, work in progress and time taken to transfer product between intermediate processing stages at this site. One manager had experience with a proprietary Du Pont process (Supply Chain Management - SCM) that was used to reduce processing times, rationalise materials and materials stock holdings, improve product quality and reliability of delivery and engage all areas of the workforce in improving processes in ways that added value to the business. As remarked by this manager:

"I'd worked in Canada where SCM was developed. It's kind of like a hybrid of TQM and JIT and uses many elements of both philosophies and provides a single unifying improvement thrust. We needed process management techniques to more systematically focus our improvement effort and manufacturing cells to better focus production effort. We also needed to collapse order-to-delivery cycle time, introduce Kanban's and improve product quality. But we also wanted a process that helped us to work with suppliers to get our materials issues addressed and work with customers to get a better understanding of their needs. SCM can help you do all these things ...and do them quickly...being based on the concepts of employee empowerment and participation, it also fitted with Stage 3 of our change plan."  

During June 1992, Fibremaker's representatives visited the US and Canada to evaluate the SCM process' suitability for implementation at their site at that time. In September 1992 a decision was taken to proceed with SCM introduction. However the principal element of Stage 3 of the change plan, the evolution of team based workgroup concepts, had already been commenced in April 1992. Fibremakers needed to decide whether to pursue with team development. At that time, the actions associated with short term survival were requiring the total and absolute attention and energy of the local management team. All other actions (eg team development and leadership training) merely diluted this focus. As noted by the CEO:

"At that time we had some parts of the organisation working on team development with others just trying to keep us afloat. But we soon realised that at that time our short term survival depended on downsizing our organisation and introducing SCM. We had to operate with less people for our cost structure to be competitive. We also had to
introduce SCM to reduce manufacturing lead time, improve customer service and rationalise our supplier base."

There were four other factors that also contributed to Fibremaker's abandoning the team development project. First, in October 1992, Du Pont (international) announced a review of all lines of business in the Asia Pacific Region. Macro decisions needed to be taken before micro structures could be put in place. Second, a further 100 employees were to be retrenched. From their earlier experiences with retrenchment processes, managers knew that this activity would have considerable impact on morale, workload and performance. Consequently, it was an inappropriate time to attempt to introduce teams. Third, macro structure change and retrenchment required as much stability and "top down" control as possible. Team development issues such as delegation of authority and changes to roles and responsibilities were clearly inconsistent with this requirement. And finally, and perhaps most importantly, teams were a mechanism for employees to aspire to their maximum potential, add their maximum value to the business and create a collaborative work environment. The increased threat of closure had, to a large extent, closed the mindset gap between workforce and management. Therefore, what was really needed at that time was not a mechanism to build commitment and teamwork but a mechanism to enable employees to make improvements in their work areas that reduced cost and waste and improved yield and efficiency. Teamwork would naturally develop through this approach and the desire to survive. As noted by two different managers:

"We didn't need teams. We needed something to improve productivity quickly and which integrated all aspects of our operations: from the bottom to the top, from the supplier to the customer, and at each and every step along our value chain. We needed something that provided a common focus and that meant something to everybody. The more we looked at it the more SCM made sense.

"SCM provided an opportunity to develop a teamwork culture that was progressed through individuals' needs to find answers to their problems rather than through a "top down" managerial initiative to develop team based work structures."

The SCM process subsequently became the core change program at Fibremakers during 1993 and 1994. It is noteworthy that a number of employees indicated that SCM training gave them a "professional edge". That is, it helped them to systematically analyse problems and develop conclusions based on logic rather than "gut feel". The advantage of professionalism was also noted at a number of other sites where employees had been provided
with process analysis and problem solving training, typically within TQM or team development programs. This quote from a Du Pont employee eloquently sums up this perspective:

"The team training's good...it not only gives you the skills to do your job better but it also helps you to convince others when you need to. I used to bring things up and no one would listen... I'd bring up what needed to be done but couldn't express it in the right way. Today I write a proposal, estimate how much it will cost, work out its advantages and its risks, look at the alternatives and so forth. Not only does this get people's attention but it gives me the confidence to argue the proposal when I need to."

5.4.2.9 Implementation Of Supply Chain Management

Fibremakers split the project into three components:

- **Continuous Flow Manufacturing (CFM)**
  Core focus: Analyse manufacturing processes to improve efficiency, improve process quality and reduce cycle time.

- **Procurement and Distribution (P&D)**
  Core focus: Work with suppliers to, amongst other things, rationalise the number of suppliers, improve material quality, increase frequency of delivery and reduce lot sizes, reduce stock holdings and reduce material costs.

- **Sales and Operations Planning (S&OP)**
  Core focus: Work with customers and other manufacturing personnel to develop customer service agreements and effective production schedules, plans and review mechanisms

Project managers were appointed for each project (CFM, P&D and S&OP) during November 1992. These three managers reported directly to the Human Resource Manager. The three projects were conducted in parallel. Each project element is discussed in the sections that follow.

5.4.2.10 Continuous Flow Manufacturing (CFM)

Following the appointment of the CFM project manager, cross functional teams of between four and eight persons were formed in each production area. One person from each shift was included and attendance was on a voluntary basis. Individuals received between 3 to 5 days of training on the SCM methodology over the period March 1993 through June 1994 which covered such areas as; the objectives for CFM, process mapping, process analysis and problem solving, the role of employees in CFM with emphasis on attitudes and skills, the
identification and development of improvements and the identification of non value adding tasks. An operator commented:

"CFM provided us with a way of getting things done. Management gave it a high profile and people couldn't walk away from suggestions that we made. The training was great. It also helped us to develop proposals in far more detail. We analysed costs, looked at alternatives and developed supporting logic. Of 68 proposals developed in our team during the last 2 years not one has been knocked back."

Training sessions included a brainstorming session where employees prepared a "shopping list" of improvement issues. Issues were prioritised, and some preliminary options for action prepared for high priority items for employees to take back to the workplace. At the worksite individuals were assigned responsibility to develop options into proposals, make recommendations and action them accordingly. For example, in training sessions for the Warpknit area, 50 initial improvement opportunities were identified. Two operators and the Warpknit superintendent subsequently worked full time on the top three issues which represented fundamental opportunities for improvement within this operation. Individuals were seconded to teams for up to four months to identify options for improvement and solicit ideas from the workplace. And finally "buck passing" was reduced by ensuring that "the person who raises the problem, fixes the problem".

Site management also demonstrated its "up front" commitment to the program by:
- investing over A$1M in its resourcing,
- allocating a full time manager and specialist support staff in the areas of computing and engineering,
- seconding a significant number of employees from the shop floor. It is noteworthy that individuals are taken off shift with no loss of earnings.
- delegated budgets and expenditure authorities to members of the improvement teams.
- arranging team members access to resources to assist in the implementation of solutions
- attending team meetings and championing specific projects

Management commitment to change programs has long been acknowledged as a key ingredient of success. Not only is this important in creating the appropriate environment for change, but a number of cases conducted would also suggest that it is important in managing employee expectations of change. Due to the traditional industrial relations practices that
prevailed at most sites, change cultures had evolved where employees typically focused on a defined set of outcomes (eg. award settlement). Due to the evolutionary, cumulative and longer term nature of the change processes adopted at a number of sites (eg Kellogg, Pampas, Du Pont, Exicom) outcomes were often unable to be specified at the outset, and if so, unable to be achieved within the timeframe of expectation. Consequently, a significant area of management work was to satisfactorily respond to employees concerns about “what's in it for me” and “why does it take so long”.

Kellogg's trialed Kanban's in two areas and subsequently introduced them site wide. An operator remarked:

“Our tube Kanban's are working extremely well, making purchases easier to control and reducing costs. Unit Kanban's were really tested for the first time last week when we had a blackout. We were able to get the plant up and running within two hours without any machine awaiting units. A year ago it would have taken us two days to sort out all the ripple effects.”

Significantly, many safety reforms also continued to happen during the period of implementation of CFM further supporting the development of a collaborative employer/employee work ethic and reinforcing employee self worth. The measurement culture developed in Stage 2 was also further reinforced as saving jobs became synonymous with improving key performance indicators. As remarked by the CFM co-ordinator:

“Our initial success with this program is largely due to the up front investment we made in leadership and our commitments to helping teams. Its continued success has been due to our ability to link improvements that come from it to jobs. This is where performance indicators come in. By making sure the metrics are simple, people can understand them and understand how their actions affect them. They (the metrics) become the real driving force for change, not how many improvements we make or how many teams we develop.”

The principal barrier encountered by CFM was sustainability. As noted by two employees:

After about 12 months (February 1994) we hit a wall. We’d addressed all the things we could in our team and were coming across a number of problems that were associated with our interface with other teams. We weren’t able to solve or implement these as we didn’t have the knowledge or authority. Sure, we formed joint problem solving teams but these issues were hard to work through and as we hadn’t worked with many of these people before, the sessions often went off the rails.”

253
"We had two people in our team 'dragging the anchor'. No matter what we did it was hard to get them involved and as we needed their input it was really hard to keep going. Also, we've done just about everything we can; the old technology in our area needs to be replaced. Management are reluctant to spend the money so why should we care."

Fibremaker's continuous improvement culture is still relatively fragile as was noticed during January 1994 when the firm made a marginal profit for the first time. Employees subsequently pursued a pay increment, negotiations stalled and commitment to the CFM program was withdrawn. At the time this study was undertaken (January 1995) Human Resource policies were being developed to support the further development of CFM. These included gainsharing, employee development, employee appraisal, leadership development and award restructuring. As remarked by a manager:

"Many people see substantial value in what's been achieved but still sit back and say "it's not my problem". Some middle managers are also "failing to let go". However, on the whole, these behaviours are decreasing as problems are addressed and a spirit of co-operation begins to emerge. We really have come a long way."

5.4.2.11 Procurement And Distribution (P&D)

The P&D manager analysed the use of the CFM technology at other Du Pont sites and developed a project scope. The specific objectives developed for this project were to reduce the costs of stock holdings and distribution/transportation, rationalise the number of suppliers, challenge the specification of materials with a view to sourcing cheaper substitutes, improve materials quality, increase the frequency of materials delivery and reduce lot sizes, simplify procurement and distribution processes and eliminate non-value adding tasks. Teams were formed during January 1993 and all employees given SCM training during that year. A small team of 6 employees mapped procurement and distribution processes and identified opportunities for improvement. The purchasing function was substantially reorganised and staff strength reduced by 15%. Many opportunities for "one-off, quick hit" type improvements were identified, prioritised and actioned accordingly. The P&D manager remarked:

"We were keen to get other staff involved as quickly as possible. We therefore allocated high priority action items to specific teams who analysed each item and developed opportunities for improvement. We then collaboratively evaluated options, selected a preferred option and gave this back to the team to implement."
All proposals and actions needed to be integrated with both the Continuous Flow Manufacturing (CFM) and Supply and Operations Planning (S&OP) projects. For example, the introduction of Kanbans to reduce stock levels and work in progress had the effect of tightening the coupling between production stages and the coupling between production and materials functions. The rationalisation of stock holdings also required close liaison with the Supply And Operations Planning Function to ensure that the materials requirements of the production plan could be met. The need for integration was greatest for the P&D project as the Procurement and Distribution function is located between the other two functions on the value chain. Consequently, monthly meetings were conducted with representatives of the other two project groups to foster collaboration, teamwork and communications.

Significant resistance to change was encountered as the procedures and systems used in the P&D were heavily institutionalised. Similar resistance was also noted in Edgell Bird’s Eye and Pacific Dunlop Bedding where roles, training, procedures and systems within the materials functions all served to reinforce bureaucratic and complex work processes. In some areas of the Kellogg’s purchasing operation the same procedures had been used for more than 20 years. Consequently, the appointment of a manager to this project with no prior purchasing experience was seen as significant as he had no preconceptions or "buy-in" to the status quo.

A separate team was formed to pursue supplier related improvements. As many suppliers were seeking quality accreditation at that time, and Fibremakers represented a potentially large customer, these organisations were highly receptive to developing closer relations. It is noteworthy that traditionally, Fibremakers had sourced in excess of 40% of its materials offshore as local suppliers were unable to meet the specified requirements. A series of meetings were convened and issues of mutual interest tabled and progressively addressed. As noted by the P&D manager:

"The agenda was very clear from the start. We needed to reduce costs and they (the suppliers) wanted to increase sales. Within three meetings a significant number of commitments were made by both sides. Initially we focused on two areas: the use of cheaper materials and the simplification of our materials supply processes. We found that we could relax a number of materials specifications, reduce costs and improve product quality. Many of our older machines operated better on substitute materials. We also found that suppliers were better equipped to store many of our materials which not only reduced our storage costs but also improved the quality of the product and reduced our downtime."

An information system was introduced in August 1993 to manage P&D project activity. At that time there were 76 active P&D projects and it had become extremely difficult to track
project status and ensure that overlaps and inconsistencies were avoided. This system has subsequently been trialed and used in the SCM and S&OP areas. It now serves as the key vehicle to coordinate projects involving more than one group.

5.4.2.12 Supply And Operations Planning (S&OP)

The principal objective of this project was to improve planning. Previously all planning activity had been performed by the marketing and planning section with minimal input from other functions. Functions such as materials and manufacturing had developed sufficient buffers to accommodate virtually any requirement and contingency. The majority of these buffers were, or would be, eliminated under the CFM and P&D projects. Further, customer service standards had also increased substantially as new competitors had entered the marketplace with delivery times by up to 50% less than Fibremakers. Information gathering sessions were initially conducted with all customers to assess current and future product requirements (quality, lot size and delivery) and develop customer performance standards. As remarked by the S&OP manager:

"The customer sessions were real eye openers. We had no idea that service norms had moved that far and knew that whatever else we did we wouldn't be here in the long term unless we could become internationally competitive in terms of customer service and product quality."

Once customer service standards were prepared, presentations and workshops were conducted with all staff to discuss the size of the service gap and gather ideas as to how to close it. Many problems and issues were raised including inadequate customer liaison, delays in receiving forecasts, a lack of commitment to the plan, an inability to effectively communicate changes to the plan, a lack of sound information with which to prepare the plan, a lack of understanding of the plan and excessive plan complexity. These issues were analysed and a model planning process defined. The model process covered issues such as: customer involvement and liaison, the roles and responsibilities of those involved, metrics to track performance improvements, information requirements, deadlines for the provision of information etc. The model was extensively discussed and debated with representatives of all stakeholder groups eg. manufacturing, suppliers, customers etc, amended and subsequently introduced. A planner remarked:

"What struck me most in these meetings was not so much what we achieved, but how we achieved it. The more we talked, the more the traditional barriers were broken down. With performance indicators used extensively, people could identify, and more importantly, demonstrate where we needed to improve. The S&OP process...to a large
Both Du Pont and Pampas have developed customer service statements to initiate organisational activities aimed at delivering step change improvements in customer service. Du Pont has also employed this technology to effect significant improvements in functional interfaces (eg. design and engineering, engineering and manufacturing).

In summary, Fibremakers have introduced savings in excess of A$50M and “given the organisation a life” through two key change initiatives; safety management and supply chain management. The safety management process has significantly improved the cooperation, trust and understanding between management and employees and created a common set of values and attitudes that has percolated into other areas of business activity, eg. quality and productivity. The supply chain management process has equipped employees in all areas of the value chain with the necessary tools and techniques to be able to identify and address organisational improvement opportunities and link them to tangible improvements in business performance.

5.4.3 Case No 3 : South Pacific Tyres

The tyre industry is extremely competitive, with manufacturers established in over 80 countries around the world. The need for greater production efficiency and the critical nature of new technology in tyre manufacturing has resulted in marked rationalisation in the industry since the mid-1970s. Between 1982 and 1986 no fewer than 27 tyre companies closed down around the world. Within Australia, economies of scale, and the magnitude of the capital investment required to be internationally competitive have seen the number of tyre manufacturers reduce from seven in 1965 to three in 1990. Competitive pressures have further increased in recent years as a consequence of the removal of protective tariffs. In the period 1988 to 1995, tariffs on imported tyres reduced from 25% to 12.5%. By 1998 a 5% level of tariff protection is predicted by industry analysts. There is also a general recognition by Australian manufacturers that their technology and productivity are poor by world standards.

Table 5.8 lists the major events in South Pacific Tyre's change process. During the late 1980's South Pacific Tyres accepted that it needed to improve its performance. As a first step the company wanted to qualify and quantify the size of gap between its own performance and international Best Practice by benchmarking leading manufacturers. As part of the world wide Goodyear organisation, South Pacific Tyres was able to benchmark with 46 plants in 25 countries. This process not only enabled the company to evaluate its relative performance along a number of axioms but also determine the key capabilities that drive Best Practice along each axiom. For example, South Pacific Tyres examined product development processes and identified Michelin's
### TABLE 5.8
**Major Events in South Pacific Tyres Change Process**

<table>
<thead>
<tr>
<th>Date</th>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>June</td>
<td>1989</td>
<td>Benchmarking commenced with leading tyre manufacturers</td>
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<tr>
<td>October</td>
<td>1989</td>
<td>Introduced performance measures</td>
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<tr>
<td>December</td>
<td>1989</td>
<td>Launched “Organisational Effectiveness” framework</td>
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<td>1990</td>
<td></td>
<td>Investigated alternative tyre building technologies</td>
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<tr>
<td>March</td>
<td>1991</td>
<td>Awarded contract to MHI Japan and formed MHI Project Team</td>
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<tr>
<td>June</td>
<td>1991</td>
<td>Operator / foreman visit MHI Japan</td>
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<tr>
<td>July</td>
<td>1991</td>
<td>Operator / foreman presentation to workforce</td>
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<tr>
<td>August</td>
<td>1991</td>
<td>Prototype (test) machine installed</td>
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<tr>
<td>July</td>
<td>1992</td>
<td>Awarded best practice grant</td>
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<td>September</td>
<td>1992</td>
<td>Commenced workforce literacy training</td>
</tr>
<tr>
<td>December</td>
<td>1992</td>
<td>Enterprise agreement finalised</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TQM Team measurement training for total workforce commended</td>
</tr>
<tr>
<td>June</td>
<td>1993</td>
<td>Changed organisational structure</td>
</tr>
<tr>
<td>June 1993 - December 1994</td>
<td></td>
<td>9 MHI Machines Installed</td>
</tr>
<tr>
<td>September</td>
<td>1993</td>
<td>First Team introduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Performance measurement software introduced</td>
</tr>
<tr>
<td>October</td>
<td>1994</td>
<td>35 Retrenchments</td>
</tr>
</tbody>
</table>
process to be superior. The company then compared Michelin's product development process to other manufacturers and identified its acquisition of a European software company specialising in three dimensional mathematics as its distinctive competency. This technology gave Michelin the capability to produce a prototype tyre within four days. The industry norm was in the order of 4 weeks with South Pacific Tyres taking four months. In another example, South Pacific Tyres identified Sumitomo Rubber Industries (SRI) as Best Practice in labour content per tyre. South Pacific Tyres then compared SRI to the other firms along this axiom and found core technology and employee involvement as the key differentiating capabilities. South Pacific Tyres found that through superior technology and the development of an empowered and committed workforce, SRI was able to take only 14 employee minutes to manufacture each tyre. The industry norm was in the order of 30 minutes with South Pacific Tyres taking 46 minutes.

5.4.3.1 Organisational Effectiveness Framework

Following the initial benchmarking exercise, the CEO together with his management team articulated an "Organisational Effectiveness Framework". This framework focused on a structured suite of investments in three key areas which are:

- **Technology**: the development of world class tyre manufacturing technology;
- **Work Environment**: The development of Best Practices in:
  - Organisational design
  - Leadership
  - Training (including English literacy)
  - Information systems
  - Safety
  - Team development
- **People**: developing employee capabilities as the centrepiece of competitive advantage
  - Overcoming resistance to change
  - Gaining union commitments
  - Employee involvement
  - Assessing the impact of technology
  - Developing Relationships

South Pacific Tyres recognised the interconnectedness between these three areas. In particular, benchmarking visits to sites using new technology had demonstrated the need for substantial investments in people and organisational processes. Each of these three areas will now be discussed in considerable detail.
5.4.3.2 Technology

South Pacific Tyres tyre building technology dates back to the mid 1970's and did not permit the plant to achieve international levels of competitiveness in terms of cost, quality or flexibility. As remarked by a senior manager:

"The old machines were responsive but they required high labour input. They were also unable to produce tyres that met emerging product specifications. We needed machines that let us increase productivity and quality while maintaining the flexibility."

South Pacific Tyres invited a number of firms offering various types of tyre technology to visit the plant. VMI and Krupp both offered sophisticated technology but it was expensive and did not readily permit customisation. South Pacific Tyres knew that these manufacturer's tyre building machines would require customisation to interface with existing plant and offer the range of product and process flexibility sought. South Pacific Tyres subsequently investigated Mitsubishi Heavy Industries (MHI) technology, and on the basis of preliminary evaluations, sent four representatives to MHI Nagasaki during January 1990 for dry test observations on their tyre building equipment.

One of the key objectives of this visit was to assess whether the MHI technology could offer the cycle times and productivity levels that South Pacific Tyres was seeking. South Pacific Tyres knew that the MHI technology would substantially reduce labour input as it allowed a tyre to be completely processed on one machine but it was unable to quantify the impact. MHI were prepared to guarantee the mechanical and electrical operation of the machine and also the design capacity of the machine. However, they were not prepared to guarantee either the labour content or the cycle times. MHI indicated to South Pacific Tyres that if the 25 existing machines were replaced by 9 MHI machines the productivity and cycle times stipulated were achievable but only if work was arranged differently and the operators performed a range of additional tasks. Therefore, South Pacific Tyres knew that its ability to realise the advantages offered by the new technology was dependent on its ability to implement the other two areas of its strategic plan as these targeted significant improvements in workplace culture. In March 1991, South Pacific Tyres awarded a contract to MHI to supply 9 machines.

The project was implemented using a conventional project management approach. During March 1991 a project leader was appointed, cross-functional project team formed and an implementation plan developed. Operators, engineers and managers indicated that this team's success was largely attributed to two issues. First, giving the project leader responsibility for co-ordinating technological, organisational and human resource changes and second, the project teams ability to communicate effectively with three key groups: MHI Japan, South Pacific Tyre's Human Resource (HR) function and the plant operators. The project team's effectiveness and status was also enhanced by sending an operator and a foreman to Japan in June 1991 to work with the
Japanese MHI team. This approach helped to ensure that operator concerns were appropriately addressed. The operator who went to Japan made the following comment:

"In the past, machinery would be dropped on the shop floor and we would be told how to install it and how to work with it with no input into it. In the MHI case, we were asked how we thought we could work with the new machine."

In July 1991, the operator and foreman made a presentation to the workforce on their trip to MHI Japan. This helped to allay fears associated with the introduction of new technology and gain the commitment of the workforce to the project. As noted by the project manager

"The operator and the foreman sold the idea to the employees at the shop floor level. Employees were asking a lot of questions after the presentation regarding the machine capability, and generally how the new technology was going to affect them and their jobs."

Shop floor employees perceived this particular operator as their spokesperson for the change process, an individual with the intellect, savvy and skills to gain the respect of management and bridge the gap between the "top floor" and the "shop floor". In particular this operator was able to clearly communicate where management wanted to go (to employees) and where the shop floor wanted to stay (to management) and this clarity of understanding helped to facilitate project progress. Through collaborative employer/employee benchmarking missions, Du Pont, Edgell Bird's Eye, Pacific Dunlop Bedding and Exicom have similarly involved influential shop floor employees in their change processes with a view to:

- ensuring shop floor concerns were adequately represented,
- gaining some ownership for the change process at shop floor level,
- developing shop floor “champions of change”,
- cascading understanding throughout the workforce,
- overcoming resistance to change.

In all instances these individuals have become instrumental in gaining workforce commitment to the change initiative and are therefore considered critical to its success.

During August 1991, a prototype machine was installed at the South Pacific Tyres plant. Extensive running of this prototype took place followed by the installation of the first production machine in June 1993 with all other 8 being installed over the subsequent 18 month period. The process of machine development took many months with several visits to Japan by the project team and several visits to Australia by the Japanese MHI team. Substantial emphasis was placed on the development of co-operation, trust and mutual respect which were fundamental values to the Japanese.
5.4.3.3 Work Environment

South Pacific Tyres sought to progress its existing work environment toward Best Practice using new technology as the "catalyst" to promote the change process. As remarked by the Manager of the MHI Project:

"We used the prototype machine as an example within the plant to demonstrate to the workforce what we were trying to achieve. We thought that if we could achieve the required attitudinal and behavioural changes in this area then we had a better chance of achieving cultural change in the rest of the organisation."

5.4.3.4 Strategic Business Units and Teams.

From its discussions with MHI and benchmarking activities with other organisations, South Pacific Tyres knew that the introduction of the new technology required an accompanying set of organisational adjustments. An organisational structure based around the concepts of Strategic Business Units (SBU’s) and work teams was preferred as this arrangement appeared support business focus, facilitate workforce commitment and productivity and reduce operating costs. In particular, South Pacific Tyres believed that SBU’s would concentrate employee effort on the core process and the manufactured product and ensure that technological excellence did not become superordinate to improved business performance. The introduction of SBU’s during also necessitated the move to 12 hour shifts in order to assure process continuity and hence reliability of product supply. The tyre building area was restructured into an independent operating group which:

- Was responsible for operating all tyre manufacturing machines and liaising directly with Production Planning rather than through a series of intermediaries.
- Had all the resources (operational and support) necessary to conduct day-to-day operations.
- Was responsible for managing its own relationships with the departments supplying tyre building components. This relationship focused, in particular, on issues of time and quality.
- Managed the allocation of resources and responsibilities to meet planning targets.
- Actively participated in the development of new products, and ensured that design "envelope" for the new technology was not exceeded.

Cross functional work teams were also developed as the new technology was introduced. An employee remarked:

"The MHI technology determines the way we work. We are relying on others and they are relying on us; so it is a team effort."
These teams were headed by a team leader and incorporated all the necessary skills (scheduling, operating, faultfinding, maintenance, inspection etc) to operate an item of plant with minimal external support. The traditional foreman/worker relationship was eliminated by subsuming the foreman into a team of equals. Similarly, Edgell Bird’s Eye and Smorgons eliminated foreman positions but at these sites considerable difficulties were encountered in maintaining the ex foremen’s commitment to the change initiative. In both these cases the individuals concerned considered that they had lost status and had less scope for development. South Pacific Tyres overcame this problem by assigning the ex foremen to different work teams, giving them a greater degree of responsibility on the new machines and providing pay increments.

At South Pacific Tyres the fundamental operating principle was changed from a "one man - my machine" basis to an operating team responsible for the continuous running of all machines. Teams liaised directly with production planning and had direct relationships with upstream component suppliers. Managers took particular care in appointing team leaders as these appointments were viewed as pivotal to the success of the project. Extensive training was provided for both team leaders and team members. Teams developed performance indicators to help operate and improve machine performance. Team leaders indicated that some teams are more advanced than others and provided a broad range of reasons for this observation including skill mix, personality mix, team experience, team leader experience and organisational support. Team members generally indicated that team experiences were positive. A number of team members also indicated that some areas of the plant were more supportive of the team concept than others, for example :

“I find that some parts of South Pacific Tyres really accept the team concept and go out of their way to help you. You’ll ring them up and before you know it they’re down here. Others seem to view us differently. For example, you raise an idea to improve something and they try to shoot you down. When that happens it’s pretty hard to have the confidence to go back again. We rely on the team leader a lot.”

5.4.3.5 Leadership

Strong support for the project, both from the CEO and management in general, was experienced throughout the organisation. This was evidenced by management’s :

- involvement in team meetings (kick off, problem solving, progress review, information sharing etc),
- ability to inspire others to continue “when the going got tough”,
- desire to solicit operator’s feedback on project performance and ideas for improvement,
- preparedness to allocate additional resources when required.
The CEO summed up South Pacific Tyres' philosophical approach to the leadership of the MHI project as:

"Our challenge was to take a whole pile of individual golfers and turn them into team players."

The MHI Project Leader explained how the CEO demonstrated his commitment to the project:

"The involvement of the CEO was not formal. He came to the shop floor every couple of weeks and spoke with members of the MHI Project team. He could see how the project was coming along simply by talking with participants. They appreciated his interest and he appreciated their candour."

The involvement of the CEO was viewed by employees as significant in demonstrating the importance of the project to the company's future success, in promoting teamwork, in showing an interest in the people that were involved and most importantly, in obtaining employee buy-in. Other managers followed the CEO's example and as employees at all levels progressively became involved in the project and committed to its outcomes, a critical mass of support emerged.

5.4.3.6 Occupational Health and Safety

Assuring the Occupational Health and Safety of all employees is a key business objective at South Pacific Tyres. Consequently there are various forums, mechanisms, policies and systems developed and responsibilities allocated to develop an effective site safety culture. All project developments and new equipment installations require the approval of the Occupational Health and Safety Committee. This committee ensures that various safety management practices and activities (eg HAZOP) have been performed and the equipment complies with all relevant safety standards.

Safety teams have been formed in all operating plants and these teams give safety check sheets for all new machines a high priority. This procedure has been followed rigorously in the installation of the MHI tyre manufacturing machines. Numerous modifications have been made to both the prototype and production machines to assure operator safety and machine integrity. When a safety incident occurs on a new machine, a senior manager is given the responsibility for its investigation and analysis. Learnings are then cascaded throughout the site using Du Pont's Stop for Safety Program.

South Pacific Tyres reviews its Occupational Health and Safety performance on a regular basis using an extensive set of performance indicators that include lost time, injury rate, severity rate, cost, number of complaints etc. Information is supplied by each work team. Like Fibremakers
and Du Pont, South Pacific Tyres believe that effective safety management practices can help improve business performance. As noted by the Safety Co-Ordinator:

"Safety should be the easiest thing to manage. People don't want to get hurt or hurt their workmates...It's common ground that links management and employees. If you can't work through a safety management program, you might as well forget the rest."

5.4.3.7 Management Systems

MHI had indicated to South Pacific Tyres that the new machines required effective information systems to both supervise their operation and monitor their performance. The two specific areas of software application were:

- The collection and analysis of data and generation of reports to evaluate machine performance. A system which enables team members to enter machine data and recall performance (e.g., output, cycle time and downtime) data to assist in planning and other key areas of decision making.

- The generation of on-line information to control and monitor machine operation. A system which provides team members with information to ensure that production requirements (e.g., quality, timeliness and volume) are met, resource (e.g., staff, materials and components) utilisation is optimised and plant and equipment is protected.

South Pacific Tyres had previously installed a system that supported aspects of this functionality but they were not regarded as "user friendly". Further, the company knew that the MHI machines required detailed and timely information in order to operate effectively and that the existing systems were "at capacity" and could not be modified to provide this additional functionality. In addition, in plants where tyre manufacturing machines were operating effectively, information systems were regarded as a useful learning tool for operators. Consequently, South Pacific Tyres considered these two systems to be vital to the success of the project. In particular, the first system supported the introduction of the performance measurement and performance improvement culture that the company was seeking. Sets of performance indicators had previously been identified to monitor machine and SBU performance and guide shop floor improvement effort. Operators had also received training in the principles of process analysis, process improvement (TQM training) and measurement. This information system provided a platform to measure machine and unit performance, identify deficiencies, make changes and evaluate improvement. The second system supported changes to workplace culture supporting the redesigned work flow and new roles and responsibilities of employees. By allocating tasks to the appropriate individuals and providing information to support their completion, this system helped to institutionalise the new "team" way of working and overcome the tendency of some employees to adhere to old cultural norms, for example, "that's my job not yours". The value of information systems in consolidating new work
arrangements was also observed at a number of other sites including Don, Smorgon, Pacific Dunlop Bedding and Edgell Bird's Eye. These four firms had all introduced information technology through highly consultative processes to both support new work arrangements and deter individuals from adhering to past systems of work.

South Pacific Tyres also knew that it was desirable for these two systems to be integrated. As remarked by a team leader:

"We'd seen systems that weren't integrated and people told us that they were disastrous to work with. To operate the machines effectively you need to frequently access technical information. If the information systems don't let you do this easily then people tend not to use them and you don't build up the data you need."

5.4.3.8 Operator Selection Process

The level of operational sophistication of MHI machine technology required operators of a particularly high calibre. Consequently, considerable effort was spent developing an effective operator selection. Comprehensive job descriptions were prepared for each MHI machine operating function and a selection processes developed to assess whether the applicant possessed the required attributes. The assessment process lasted 6 hours and consisted of 8 core areas that included numeracy, mechanical reasoning, literacy and conceptual ability. In addition all applicants completed a team-based activity and a personality profile. Successful applicants were subsequently provided with MHI machine training.

5.4.3.9 Training and Skill Formation

South Pacific Tyres training effort is directed by a corporate steering committee chaired by the General Manager Manufacturing. Since 1992, South Pacific Tyres has committed 3% of pay-roll, on average, to training. Key areas of investment have been in the areas of workforce literacy and numeracy, TQM, JIT, team development and measurement. This training has included a wide range of activities at all levels of the organisation to support change and the attainment of world class standards of performance. South Pacific Tyres has a dedicated training facility that provides many different areas of training including TQM for all levels of management, product specific training for employees and customers and a number of specialised programs ranging from pneumatics/hydraulics through to plant security. The training centre has adopted an innovative approach to training by supporting activities such as literacy training, adult apprenticeships and industry specific traineeships.

A detailed training strategy was developed for the MHI project. The plan incorporated a number of different training approaches including: Objective Based Training (OBT), vendor training and structured on the job training. OBT was also used by Australian Newsprint Mills and Don and has two major characteristics:
• Training is based on actual job performance requirements and
• Trainees progress at their natural pace.

Consequently, significant resources needed to be allocated to the development of OBT material as the courses were tailored to the characteristics of the specific installation. OBT programs were specifically designed as learning guides rather than descriptive manuals. Both trainee and trainer commit to a contract at the start of the course which clearly defines expected outcomes and the effectiveness is assessed at the end of each module by the completion of a number of set tasks.

The Training Coordinator remarked:

"We knew that significant operator and team training was required with the new machines. However, some of our people indicated that past training experiences weren't particularly positive as the skills learned were either not related to their particular need or were hard to apply in the workplace. We thought OBT might be a better way of going about it...we were right."

A detailed manual was developed to support the OBT training of MHI machine operators. This manual was prepared by operators, maintenance staff, foremen, technical groups and training personnel and consisted of modules covering all aspects of MHI machine operation and maintenance. Having the target audience prepare the source manual helped to ensure that it focused on key issues, was couched in the appropriate terms and was accepted by the workforce at large.

Team leaders received formal training in team development, team operation, team leadership, quality management tools and techniques and measurement. Team member training emphasised quality management tools and techniques. As remarked by a team member:

"Team training undertaken as part of the MHI project helped us in a number of ways. It gave us a good understanding of what customers and the business needed from us, something that most of us hadn't had before. It helped us to develop performance measures and use them to make improvement. It gave us the skills to map out and analyse our process which we used to improve quality and reduce processing time and cost. For example, our team identified a problem with the level of rejects. Some of us got together and worked out what we needed to do to diagnose the source of the problem. We did some tests, found the problem and decided what to do about it, calling in people from other areas as we needed them."


5.4.3.10 Literacy/Numeracy Training

Over 70 per cent of South Pacific Tyres’ workforce come from a non-English speaking background (NESS), with over thirty different nationalities represented. Similar, if not higher percentages of NESB employees were also found at Kellogg, Fibremakers, Smorgons, Exicom and Don. Consequently considerable resources were invested at these sites in developing English literacy skills to enhance understanding of the change process and effectiveness of training, improve communication and participation, and where appropriate, assist in the introduction of teams and use of computers. As the MHI project was accompanied with the introduction of teams and extensive use of computerised systems, the development of literacy/numeracy skills and basic communication skills were given a high priority at South Pacific Tyres. The company developed a training program which sought to satisfy three key objectives:

- Develop language, literacy and numeracy skills to a level that enables individuals to be assessed for MHI operator positions.
- Link language, literacy and numeracy training to data entry computer skills training.
- Link basic maths and numeracy skills to MHI machine operation.

This program has been running since September 1993 and South Pacific Tyres regard it as a key plank in the development of a work environment that supports MHI technology. As remarked by the training co-ordinator:

“It sounds fairly basic, but one of our biggest problems in the past was that we assumed that people possessed enough of a basic command of English to communicate with one another effectively. I believe that providing literacy training before we started on the MHI training program was one of the main reasons that it was so successful.”

5.4.3.11 Benchmarking and Measurement

Benchmarking and measurement were integral elements of the process to develop the work environment at South Pacific Tyres. The company has benchmarked the performance of its tyre building machines against comparable facilities within Australia and overseas on a regular basis since 1990. Areas of comparison include tyres manufactured per day, lost time incident frequency rates, defect rates and manufacturing costs. A senior manager made this comment in respect to the effectiveness of benchmarking:

“Benchmarking has been a useful tool to raise people’s awareness of the need for improvement. We openly publicise the results and all employees can see the magnitude of the gap between our performance and Best Practice. It also helps us to identify specific areas requiring improvement and focus improvement activity in these areas.”
All operators receive instruction in measurement concepts and improvement tools and techniques as an element of TQM training. As discussed in Section 5.4.3.7, performance measurement systems have been installed on the shop floor to enable operating teams to compare their performance to other teams, both on site and international Best Practice across measures that include tyres per day, minutes per tyre, percentage of defects and uptime. A number of staff indicated that these comparisons had helped to develop a ‘competitive spirit’ between various SBU’s. It is noteworthy that token rewards are also offered to those plants with the best performance at the end of each month. Some employees indicated that the measures used were overly simplistic and more detailed metrics were required in order for the information to be meaningful. For example, SBU expenditures need to be broken down by activity type so that areas of excessive activity can be compared and differences analysed.

5.4.3.12 Resistance to Change and Union Involvement

In December 1992 an enterprise agreement was introduced which included commitments by employees to change. However despite these commitments and the considerable efforts of management and shop floor representatives, there was a small group of shop floor employees that did not accept that the new technology was required and/or did not consider that technology would improve their quality of working life. The roots of this resistance stemmed from a number of areas. First, fear of the unknown. The MHI Project Leader commented that:

"Some people became anxious when their old and familiar technology was being threatened with something new and uncertain. A lot of these people were afraid that they would not have the ability to be move into MHI operator positions."

Management attempted to remove this fear by indicating that they understood and accepted that some employees, particularly those in the “twilight” of their working years, may not want to be retrained and indicated that they would endeavour to redeploy these individuals to other areas of the plant. Management also attempted to reduce resistance by continuing to educate employees of the connections between best in class performance, use of current technology and adoption of innovative organisational practices.

Second, communication. Some employees did not understand the vision and change process as they were from a non-English speaking background. South Pacific Tyres attempted to address this issue through literacy training and numerous small group discussions.

Third, jobs. South Pacific Tyres indicated that the introduction of new technology would be associated with less jobs but indicated that it could not quantify how many retrenchments would occur until the technology was fully operational. An operator remarked:
"I can see that to justify spending A$200M on new technology you need to substantially improve company performance and possibly reduce the number of jobs, but I can't see why you need to spend that money in the first place."

Individuals subscribing to this view generally believed that the company could improve its performance by actions that did not involve large expenditure or the loss of jobs. Others held the view that the new technology should be justified on the basis of greater profits through business growth rather than greater profits through less jobs. Still others doubted the company’s rationale for change and believed that the company would remain profitable into the future if no significant investment was made, or alternatively, considered that whilst the company continued to return reasonable profits it had no need to make the investment. Clearly the level of resistance had reduced substantially since the commencement of the project with most employees appearing to support, albeit passively, the actions that the company had taken. The following quote typified the general attitude of shop floor staff toward technological change:

"Management were open about it right from the start of the project. Many of us understood the reasons for the new technology and that ... if South Pacific Tyres was to have a future, technological and organisational change had to be accepted by the workforce. I think that more people are at that point today than were 3 years ago."

South Pacific Tyres also believed that two other actions helped to reduce the resistance to change: including an operator in the MH1 project team and being awarded a grant under the Best Practice Demonstration program. Having an operator in the team helped to ensure that operators’ concerns and expectations were addressed and also assisted in the creation of a more collaborative and open change environment. The Personnel Manager summed up the impact of the Best Practice grant:

"The Best Practice Demonstration Program is endorsed by the federal and state bodies of the major unions represented on site. Consequently when we were awarded a Best Practice grant to develop work teams, this endorsement helped to get our people involved and committed to our MH1 project as team development was an integral part of the MH1 project. From day one shop stewards were involved, addressing the Best Practice launch and accepting the fact that things were changing. This sent a positive signal to the workforce and ultimately helped to minimise resistance to the change process."

South Pacific Tyres' site history of working closely with employees and unions on matters of mutual concern also played a crucial role in gaining acceptance of the need for change. South Pacific Tyres' Personnel Manager remarked:
“We’d talked about technological change for a long time with the union. They knew it wasn’t a question of whether we’d change but when we’d change. Our long term relationship with the union helped most employees understand that the introduction of this new technology would provide improved long term job security through achieving world class standards of cost and quality.”

Resistance to change was a key issue at many sites. Table 5.11 identifies barriers to change reported at each site while Section 5.6 provides a discussion of specific issues. The most commonly reported barrier was associated with retrenchment. Many employees considered that by contributing to the change process they would be contributing to the loss of their own, or their workmates, jobs.

In many firms, for example Du Pont, Kellogg, Pampas and Pacific Dunlop Bedding, management made considerable attempts to increase employee understanding and acceptance of the firm’s vision and change drivers with a view to overcoming employee resistance to change. Du Pont, in particular, believe that their ability to gain employee commitment to the firm’s vision was the single most important activity in overcoming resistance.

Du Pont spent 12 months developing a detailed vision for the organisation. This vision was based on extensive market, industry, competitor, customer, vendor and internal research and identified the types of organisational behaviour that the company would strive to develop. The vision was extensively discussed, debated and reviewed by the management team. One member of the team resigned. Consensus was reached with all remaining members of the team before the vision was launched. The launch was accompanied with a series of small group workshops convened by the CEO and members of the management team. The time investment was significant. Over a 3 month period all employees attended a 2 day visioning workshop. This process was immediately followed by a series of activities that energised various aspects of the vision and demonstrated management’s commitment to it. The organisation was restructured into strategic business units to demonstrate increased product and customer focus. Cross sectional task forces were formed to develop customer service agreements. Site consultative committees were formed to commence the process of employee involvement. A$50M capital expenditure program was announced to introduce computerised systems for process supervision and control. A process to pursue the introduction of an enterprise agreement was commenced to further debate and clarify organisational and employee values articulated in the vision. Three benchmarking missions involving groups of between 8 and 10 employees were initiated to review organisational best practices. A comprehensive visioning communications strategy was launched consisting of forums, bulletin boards, suggestion schemes, newsletters, seminars and further workshops. The management team undertook a detailed strategic planning process to further refine and mould the company’s future directions. The visioning process and the subsequent suite of activities that occurred built a single common focus for change, obtained employee ownership of aspects of the change process at many different organisational levels and fleshed out, addressed and removed pockets of resistance. Du Pont ensured that the change
process was carefully nurtured during the first two to three years to ensure that employees were involved at a natural, rather than forced, pace and a critical mass of employee support evolved. It is noteworthy that this process was not facilitated by the introduction of staffing level agreements.

5.4.3.13 Employee Involvement, Consultation and Contribution

The CEO expressed his view on employee involvement:

"If we are to achieve and maintain world class status we must effectively earn the interest, enthusiasm and support of all employees. Only by all of us harnessing the sum total of our ideas, suggestions, creativity and capacities will our viability be assured."

The values and philosophy statements of all 12 firms clearly emphasised the role of employee contributions in creating a sustainable source of competitive advantage. Most firms had also developed detailed policies on employee involvement and consultation with significant emphasis placed on the introduction of differing forms of team based activity. As remarked by the change champion at Smorgons:

"We view our ability to capitalise on the skills and intellect of our people as one of the most important, if not the most important, capability that we need to develop. We see teams as one step along the way to achieving this. By introducing teams we have been able to create a work environment based on empowerment. This has enabled us to get people involved and get them to accept responsibility. By doing this we've been able to break out of the reactive approach to performing work and move toward continuous improvement."

South Pacific Tyres was typical of the organisations studied and had developed policies including supervisor led group meetings, consultative meetings chaired by business team managers and involving all plant committees, project teams, cross functional quality improvement teams, adhoc problem solving teams, shop floor work teams and safety committees involving shopfloor health and safety representatives, site management and corporate safety personnel. This policy was also endorsed by the site unions as it was totally consistent with the Australian Council of Trade Union's policy on consultation and participation. The involvement of union employees in these forums helped to get people involved and be prepared to voice their opinion.

South Pacific Tyres wanted to further develop consultative practices through the plant wide introduction of the MHI technology. Many employees remarked that the single, most significant action that helped people to become involved was taken very early in the project. The MHI Project Manager commented:

"We had nothing to hide from employees. The best thing we did was to open it up from the start. The prototype machine was placed in the middle of the plant for everyone to see and
ask questions. This approach created a lot of interest; everyone could see what new equipment was coming and how it differed from the existing equipment."

The development of a detailed communication strategy was also a key element of the process to engage employees in the MHI project. This strategy incorporated a number of elements:

• a monthly newsletter titled “Building The Future - MHI Update”,
• information sessions for all staff following visits to MHI Japan,
• a bulletin board to post notices and diagrams describing the projects’ progress,
• an employee suggestion scheme specifically for the MHI project
• the appointment of shift spokespersons

Spokespersons have been elected by each shift panel to communicate to management issues concerning each particular shift. Two way radios have also been supplied to personnel to simplify communication and information transfer between operators, component and materials suppliers, planners and sales staff.

In summary, South Pacific Tyres’ ability to accompany a $200M technological investment with a structured set of organisational and human resource investments (eg. recruitment, training and staff development, award restructuring, organisation design, teams and information systems) has improved productivity and quality and also acceptance of company direction and the need for change. However, there remains a significant gap between site performance and world class and the issue of retrenchments remains highly contentious. During October 1994, 35 retrenchments occurred and this had the effect of straining the relationship between management and the shop floor and rekindling opposition to change. The company is now attempting to address the issue of machine manning levels. There is now a clear understanding of what is, and is not, possible using the MHI technology and general acceptance amongst managers that it will be difficult to progress the development of site culture unless the manning issue is resolved.

5.5 Outcomes Of The Change Activity

Firms were asked to identify the outcomes of the change process. Information was obtained by three different individuals within each firm to check for consistency and bias. Opinions were sought from the following population: CEO, change champion, site manager, functional manager, Human Resource manager, supervisor, team leader and shop floor representatives. Data obtained was generally consistent across all three sources although some minor areas of positive and negative bias were detected eg. change champions overstating program outcomes, shop floor
employee with job security fears understating program outcomes. Both quantitative and qualitative responses were solicited (refer Tables 5.9 and 5.10 respectively).

Consider quantitative outcomes. As expected, the list of outcomes is long and varied being somewhat dependent upon the change drivers, change environment and type of technological, organisational and human resource investments made. For example Kellogg's change process targeted the simultaneous improvement of many dimensions of performance/competitiveness including technological competitiveness, processing capacity, customer focus, processing time, materials costs, productivity and workforce skills. Pampas' change process focused on quality, capacity and technological competitiveness only. Therefore it is to be expected that the change process outcomes reported by these sites vary substantially.

All sites implemented TQM. Consequently, it is to be expected that all sites would achieve improvements in quality and workforce skills. This was found to be the case. 9 sites introduced AMT as part of their change process however only 7 of these 9 sites reported the benefit "leading edge of manufacturing technology". Don and Smorgons were the two firms that made AMT investments but did not report this benefit. Don had invested A$7.9M on manufacturing based technologies including FMS, Automated Materials Handling and Bar code systems. Smorgon had invested A$10M on design based technology (CAD) and manufacturing based technologies that included CAM installations in two key areas of their plant. Both firms indicated that the technologies installed were in fact "leading edge" but they had yet to realise this potential because of shortcomings in human resource and organisational areas. Consequently, they had yet to achieve this outcome.

Six firms also indicated that they had implemented JIT. Outcomes obtained were mixed as different firms introduced different JIT practices to address different operational needs. For example materials represented approximately 50% of unit cost at Edgell Bird's Eye. Consequently, they focused on the development of collaborative arrangements with a select number of suppliers to reduce materials costs. Pacific Dunlop Bedding was confronted by customers demanding an increased product range and faster order to delivery times. They responded by introducing Kanbans, reorganising plant layout and streamlining work processes to compress order to delivery time and improve flexibility. Du Pont wanted to reduce its A$20M stockpile of materials and streamline its production processes. They worked closely with customers and suppliers to change product specifications, rationalise product ranges and move toward an operation characterised by frequent supplies of standardised materials, responsiveness and frequent deliveries of standardised products. As a result both the cost of inventory and cycle time have reduced substantially.

In respect to qualitative outcomes, all firms indicated that the change process had a positive effect on internal relationships and all firms, except Smorgon, reported extensive use of teamwork. However, care must be taken when interpreting these results.
<table>
<thead>
<tr>
<th>SLZ</th>
<th>IMPROVED QUALITY</th>
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<tbody>
<tr>
<td>IMPROVED MANUFACTURING COSTS</td>
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<tr>
<td>REDUCED INVENTORY</td>
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<td>REDUCED LABOUR</td>
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<td>REDUCED CYCLE TIME</td>
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<td>INCREASED CAPACITY</td>
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<td>LEADING EDGE OF TECHNOLOGY</td>
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**TABLE 6.9**

Quantitative Outcomes
<table>
<thead>
<tr>
<th>QUALITATIVE OUTCOME</th>
<th>FIBERMASERS</th>
<th>KELLOGG</th>
<th>SOUTH PACIFIC TYRES</th>
<th>DU PONT</th>
<th>EDGELL BIRDS EYE</th>
<th>AUSTRALIAN NEWSPRINT MILL</th>
<th>PAMPAS</th>
<th>MURRAY GOLDBURN</th>
<th>PACIFIC DUNLOP BEDDING</th>
<th>EXICOM</th>
<th>DON SMALLGOODS</th>
<th>SMORGONS</th>
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<tbody>
<tr>
<td>Shared Vision: Employees understand and accept the firm's vision</td>
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<tr>
<td>Shared Values: Alignment between employee values and stated company values</td>
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<td>Acceptance of Change: Employees commit to the company's change process and accept that change is a continuous process</td>
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<tr>
<td>Distributed Leadership: Many ideas for change are generated, developed and implemented by the shop floor</td>
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<tr>
<td>Internal Relationships: Employee/employer relationship demonstrates trust, goodwill and mutual respect</td>
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<td>External Relationships: Commitment to develop external relationships which enhance firm competitiveness</td>
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<td>Customer Focused: Employee's understand and work to satisfy customer needs and expectations</td>
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<td>Time and Quality: Time and quality are core employee values</td>
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<tr>
<td>Learning/Improvement: Employees commit to the ideals of a learning organisation and continuous improvement</td>
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<tr>
<td>Teamwork: Extensive use is made of teamwork and collaborative problem solving forums</td>
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<td>Empowerment: Structures, systems and cultural norms support the devolution of responsibility and the linkages between individual/team activity and business/organisational improvement</td>
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First, consider the relationship between the 10 change elements, AMT, JIT, TQM and the 7 practices and internal/external relationships. The process of awarding the Best Practice grant required both employers and employees to commit to the objectives of the designated change activity and this helped to build goodwill. As noted by the change champion at Exicom:

"We wouldn't have got the Best Practice grant unless managers, unions and employee representatives signed on the dotted line to indicate that they supported the change process. To achieve this commitment we had to have many meetings to iron out our differences. This process helped us to understand each other's differences and built a lot of goodwill between the parties, probably as much as the actual change process itself."

Also, change activities were co-ordinated at all sites by a consultative committee which helped to build trust and understanding between employees and employers. Consequently, improvements in relationships were due in part to the process used to co-ordinate change activities, rather than the change activities, per se. Finally, many other factors not directly associated with the change process acted to improve the employee/employer relationship during the period that change activities were implemented eg. less disputation due to the effects of the recession, "militant" employees accepting severance packages, less supervision and the rationalisation of trade unions.

Second, teamwork. There is a one to one correspondence between those firms that have introduced teams and those that report an improvement in teamwork. Consequently, it is reasonable to assume that respondents have interpreted the introduction of team-based work structures as improving the extent of teamwork behaviour. However, there were some firms, for example Murray Goulburn and Pampas, where work teams were effectively groupings of individuals with minimal overlap or interdependency between their roles and separate, rather than common, objectives. This position can be contrasted to South Pacific Tyres and Du Pont which not only demonstrated extensive teamwork within team structures (eg. peer training, high level of multiskilling, role flexibility, attitudinal flexibility, common goals etc) but in other work areas, for example employees volunteering to work on adhoc problem solving teams. A Du Pont manager summed up the difference between the formation of a workteam and teamwork:

"It's relatively easy to empower people and form workteams ... but it's a totally different thing to get them to accept responsibility and practice teamwork. Workteam development is largely about working on the environment in which people work... the structure, work systems and procedures, the design of jobs, the level of supervision etc, but teamwork is all about an individual (or groups) attitudes and values. The two are interrelated but if you've got one you don't necessarily have the other."
Although all firms had implemented TQM, two firms, Du Pont and Don indicated that increased customer focus, that is improved employee understanding of customer's needs and expectations, was not an outcome of the change process. Both firms indicated that this was a consequence of changes to customer service standards and product lines that had occurred during the change process. These changes had yet to be effectively understood by the workforce although both firms believed that there were many positive signs that employees were working toward this goal.

Only three firms, Fibremakers, South Pacific Tyres and Kellogg indicated that the change process had improved the alignment between employee and stated company values. These firms had developed detailed statements of values and investigated considerable time and effort communicating, debating and refining them with employees, a process that also occurred in some other firms. However a number of specific issues differentiated these three firms. Consider Fibremakers. Fibremakers attribute its success in aligning values to its Safety Management processes. In 1989 Fibremakers' Lost Time Injury Frequency Rate (LTIFR is the hours lost per million hours worked) was 62.6. Today it is 1.8. Worlds Best Practice for this type of plant is 0.8. Clearly, a new occupational health and safety program alone could not provide the degree of improvement required. Fundamental initiatives needed to be introduced to bring about a massive cultural change at the plant. Fibremakers developed and introduced statements of values and then went about building them into the operating culture using safety. The safety coordinator outlined the approach:

"People were 'turned off' when we started. turnover was high, there was no training or investment... morale was really low. The new management indicated the power of developing a culture based on shared values in turning things around and the opportunity available to us in the safety area. Our values' statements covered a number of areas...one included words around encouraging people to participate, valuing their contribution, giving them more responsibility and more interesting work, recognising and rewarding performance, providing opportunities for learning and so on... all the things we weren't particularly good at. By making sure that everything we did in safety built off this set of values we not only dramatically improved our safety performance, but we also got people to realise that how felt about the company was important and we helped build their trust in the new management team."

South Pacific Tyres' approach was very different. They believe that alignment of values has been facilitated by embedding values in those systems used to energise strategic intent and in giving employees a large degree of responsibility for the implementation of these systems. South Pacific Tyres have articulated company direction in the form of vision and mission statements and
three change systems: technology, work environment and people. South Pacific Tyres have ensured that these systems are linked to the development of a specific set of operating values that are supported by all members of the management team. For example the development of open communications is a core operational value. This value is embedded in the people system (communication skills), the organisational system (work and job design) and the technology system (radios, EMail). Shop floor employees are heavily involved in the implementation of each system which helps to facilitate understanding and commitment to the actions taken and the set of values that underlie them.

Kellogg also believe that employees are committing to company values largely as a consequence of committing to the company's future direction. Kellogg conducted a series of workshops with all employees to explain the firm's future direction and give all employees an opportunity to contribute. Strategies were subsequently developed to progress the organisation toward its desired state and these strategies were underpinned by a set of values aligned with customer requirements and the financial performance requirements of the firm. Values statements have also been couched in words that employees understand. As remarked by the CEO:

"We've seen and used values statements that border on 'statements of motherhood' or only have real relevance to the human resource function. Ours is expressed in words that mean something to people. We talk about the customer as being our boss, people being responsible for their actions, doing those things that benefit us all...if people can't relate to it you might as well forget trying to put it into practice."

There were also only three firms, Fibremakers, Du Pont and Edgell Bird's Eye that reported the change program to have increased employee's acceptance of change. Two of these firms, Fibremakers and Edgell Bird's Eye indicated that this support was largely associated with the large scale transformational change activities that had occurred as a consequence of the operations losing money. Further these large scale change were also widely experienced across the relevant industry sectors (Textiles and Food Processing) further helping to educate employees of the need for change and assisting them to accept change. Du Pont, a highly profitable organisation, believed that the improvement in acceptance to change observed during the change process was associated with their ability to link shop floor change to improved business performance and employee remuneration to business performance. Employees could see how changes introduced into the workplace made a difference to the business and managers nurtured this process by rewarding employees for accepting and implementing change.

It is also noteworthy that only four firms indicated improvements in distributed leadership, the number of ideas generated, developed and implemented by the shop floor, increased as an outcome of the change process. This finding would tend to lend support for the observations made
earlier regarding teamwork, that is, that although most organisations have introduced workteam structures a significant number do not demonstrate teamwork. A characteristic of organisations that make extensive use of teamwork is a high degree of self management and acceptance of responsibility by all employees which leads to many ideas for change originating from employees.

The literature reports that synergistic benefits accrue from implementing various combinations of practices and aspects of AMT. Firms were asked whether they believed they had gained synergistic benefits as a result of the implementation of their change process. Responses were mixed and varied, both between firms and from differing individuals within a particular firm. As expected most of the positive responses came from those firms that made the broadest set of investments (eg. Kellogg, Du Pont, Edgell Bird's Eye, Pacific Dunlop Bedding). Synergistic benefits were also reported by Exicom, which is to be expected, as plants manufacturing telecommunication equipment are highly automated and extensively integrated. Synergistic benefits reported were also often unanticipated. Pampas reported improved communication between research and development and manufacturing as a result of implementing their CAD/CAE system. Edgell Bird's Eye reported integration of their MRP system with automated material handling systems streamlined and automated many cost accounting, material tracking and inventory management functions. Australian Newsprint Mills also noticed marked improvement in performance in working with a common database. For example, engineering change orders were updated once rather than in five separate databases. As a result data integrity and accuracy improved.

Other firms noted synergies associated with the use of soft management technologies and best practices. For example, Du Pont reported that TQM enabled them to improve product quality tenfold and that this in turn enabled them to further reduce material stocks, a key objective of their JIT program as they no longer needed to protect against quality variability. Edgell Bird's Eye indicated that their JIT program focused on working collaboratively with a small group of suppliers to reduce materials costs and the range of materials processed. However they also found that by rationalising their supplier and materials base, plant and equipment operated with less breakdowns and produced product of better quality. Consequently, JIT helped to improve reliability of delivery and product quality, key objectives of their TQM program. Other firms reported synergies between practices. Smorgons reported that benchmarking helped them to establish and review business goals and consequently improve the effectiveness of their strategic planning process. They also indicated that an effective strategic plan helped to ensure that the appropriate areas were benchmarked and therefore, that benchmarking was of strategic value to the business. Australian Newsprint Mills found that TQM provided employees with the tools and techniques needed to analyse benchmarking data which enabled benchmarking to be used to drive continuous improvement. Moreover they also found that benchmarking provided a set of measures and metrics to direct quality improvement. Fibremakers found that removing the barriers to change and helping
employees to embrace change substantially improved their distributed leadership capability. Kellogg also found that an appropriate set of human resource management strategies substantially helped in ensuring that quality improvements were maintained. For example by recruiting people with an aptitude for teamwork and change, Kellogg was able to reinforced the team culture that it was trying to develop.

5.6 Barriers to Change

As this research is concerned with extracting learnings from firm's experiences in implementing change, barriers to change were identified and analysed. As expected, barriers are dependent upon change drivers, change environment, change strategy, change elements, change champion etc and as a consequence many different barriers were experienced by the firms studied at various stages in their change process. Table 5.11 lists the barriers identified by the 12 firms. It was expected the number of barriers would be somewhat less in those firms with a strong driving force for change, eg. threat of closure, however inspection of Table 5.11 shows that with the exception of Fibremakers, this is not the case. In fact Edgell Bird's Eye, a firm facing imminent closure, reported the greatest number of barriers.

A framework has been developed to structure the discussion of barriers. This framework consider the barriers encountered by the various firms at three different stages of their change programs, commencement, implementation and completion. It is accepted that this framework may over-simplify some firms' change processes as more than one change process may be occurring at any point in time and these change processes may be at different stages. Also change is a continuous, rather than discrete process. However, it is not considered that these issues will substantially impact on the conclusions reached.

For the 12 organisations studied, it appears that two different types of change barriers were experienced: principal and contributory. Principal barriers prevent a firm progressing through the various stages of its change process with contributory barriers adding to the degree of difficulty encountered. Many different contributory barriers were observed including entrenched industrial relations attitudes, poor communications, heavy workload and retrenchment but only 5 principal barriers were found. These are (the stage of the change process at which the barrier was first observed is given in brackets):

- lack of real pressure for change (commencement)
- employees don't accept direction for change (commencement)
- ineffective or inappropriate change plan (commencement/implementation)
- inability to implement change (implementation)
<table>
<thead>
<tr>
<th>Firm</th>
<th>Barriers To Change</th>
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<tbody>
<tr>
<td>Australian Newsprint Mills</td>
<td>Retrenchment&lt;br&gt;Resource Limitations&lt;br&gt;Complexity of the change plan&lt;br&gt;Poor employee morale&lt;br&gt;Demarcation restrictions&lt;br&gt;Middle management don't accept direction and don't want to become involved&lt;br&gt;1993 industrial dispute&lt;br&gt;Ineffective Consultative committee&lt;br&gt;Poor history of implementing change</td>
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<td>Don Smallgoods</td>
<td>Middle management don't accept direction and don't want to become involved&lt;br&gt;Lack of real pressure for change&lt;br&gt;Poor communications due to language barriers&lt;br&gt;Change champion (consultant) lacked understanding of site issues and culture&lt;br&gt;Responsibility for implementation of aspects of change process is unclear&lt;br&gt;Employees don't accept company direction&lt;br&gt;Workforce skills&lt;br&gt;Industrial relations reform process&lt;br&gt;Few shop floor change champions&lt;br&gt;Fast pace of reform</td>
</tr>
<tr>
<td>Du Pont</td>
<td>Inadequately detailed change plan&lt;br&gt;Insufficient corporate “buy in” to change plan&lt;br&gt;High employee expectations of change&lt;br&gt;Loss of change champion at critical stage of change process&lt;br&gt;Underestimating the complexities of implementing change</td>
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<tr>
<td>Edgell Bird's Eye</td>
<td>Geographically diffused resources&lt;br&gt;Complexity of the change plan&lt;br&gt;Lack of business/organisational diagnosis prior to developing plan&lt;br&gt;Insufficient senior management “buy in” to change process&lt;br&gt;Deteriorating business environment (major “attention diverter”)&lt;br&gt;Abandonment of some aspects of the change process&lt;br&gt;Removal of one level of middle management&lt;br&gt;Excessive focus on short term issues: long term perspectives lacking&lt;br&gt;Poor measurement systems to track improvement&lt;br&gt;Retrenchment&lt;br&gt;Ineffective consultative committee&lt;br&gt;Poor history of implementing change&lt;br&gt;Underestimating the complexities of implementing change&lt;br&gt;Employees don't accept company direction&lt;br&gt;Fast pace of reform&lt;br&gt;Lack of real pressure for change</td>
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<tr>
<td>Firm</td>
<td>Barriers To Change</td>
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| Exicom       | Traditional industrial relations attitudes and tensions  
Poor communications due to language barriers  
Ineffective Consultative committee  
Insufficient customer and supplier involvement in change plan development  
Changes in key personnel over the life of the project.  
High employee expectations  
Middle management don't accept direction and don't want to become involved |
| Fibremakers  | Heavy workload  
Resource limitations (people and money)  
Workforce skills |
| Kellogg      | Entrenched union/employer attitudes  
Lack of employee preparedness to implement change  
Poor communications due to language barriers  
Workforce skills  
Lack of real pressure for change  
Industrial relations reform process  
Gaining employee trust and respect  
Few shop floor change champions  
Underestimating the complexities of implementing change  
Employees don't accept company direction |
| Murray Goulburn | Low level of new CEO “buy in” to change process  
Low level of organisational “buy in” to change process  
Emerging business pressures (deteriorating product prices, seasonality etc)  
Disconnect between change strategy objectives and business plan  
Poor communications  
Resource limitations  
Employees don't accept company direction  
Lack of real pressure for change |
| Pacific Dunlop Bedding | Low level of management team “buy in” to change process  
Lack of real pressure for change  
Lack of business/organisational diagnosis prior to developing plan  
Resource limitations  
Poor communications due to language barriers  
Disconnect between change strategy objectives and business plan  
Poor history of implementing change  
Geographical dispersion of resources  
Underestimating the complexities of implementing change  
Employees don't accept company direction  
Fast pace of reform |
<table>
<thead>
<tr>
<th>Firm</th>
<th>Barriers To Change</th>
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<tbody>
<tr>
<td>Pampas</td>
<td>Middle management don’t accept direction and don’t want to become involved</td>
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<tr>
<td></td>
<td>Ineffective Consultative committee</td>
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<td></td>
<td>High workload: energy dispersed</td>
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<td></td>
<td>Poor communications due to language barriers</td>
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<td></td>
<td>Workforce lost confidence in change champion</td>
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<td></td>
<td>Traditional industrial relations tensions</td>
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<td>Poor workforce understanding of rationale for change</td>
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<td>Unable to meet employee’s expectations</td>
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<td></td>
<td>Technologically driven site culture</td>
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<td></td>
<td>Employees don’t accept company direction</td>
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<tr>
<td>Smorgons</td>
<td>Low level of new CEO “buy in” to change process</td>
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<td></td>
<td>Low level of organisational “buy in” to change process</td>
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<td></td>
<td>Resource limitations - during program</td>
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<td>Resources removed before gains institutionised resulting in slippage</td>
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<td>Change process given low organisational status</td>
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<td></td>
<td>Poor measurement systems to track improvement</td>
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<td></td>
<td>Poor communications due to language barriers</td>
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<tr>
<td>South Pacific Tyres</td>
<td>Demarcation restrictions</td>
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<td></td>
<td>Threat of retrenchment</td>
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<td></td>
<td>Employees fear of new technology</td>
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<td></td>
<td>Inability to leverage off new technology in some production areas</td>
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<td></td>
<td>Individual socialised to needs of the discipline rather than needs of the team</td>
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<td></td>
<td>High workload : simultaneous technological and organisational change</td>
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<tr>
<td></td>
<td>Underestimating the complexities of implementing change</td>
</tr>
<tr>
<td></td>
<td>Employees don’t accept company direction</td>
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</table>
inability to develop work environment to sustain improvement (implementation/completion)

To commence the process a real pressure for change appears to be needed to gain the organisation's attention, create the required sense of urgency and make employees understand that the status quo is not a stable state. Kellogg's experiences typified those of a number of firms that struggled early to launch their change process because of insufficient driving force for change. This was also clearly observed at Pacific Dunlop Bedding and Don Smallgoods. These organisations found that the change process was difficult to start and lacked momentum. In the case of Pacific Dunlop Bedding, it was effectively individually championed at organisational level. Once the need for change was established, employees commitment to the intended direction needed to be gained in order for the process to proceed effectively. South Pacific Tyres and Australian Newsprint Mills struggled in this area as concerns with new technology and job security prevented the development of a clear and common direction. At these sites the change activity became extremely complex as some initiatives were introduced to mitigate rather than address these influences and still others used to "kick start" the change process. Consequently, change effort became diffused across a large number of relatively independent activities rather than concentrated in a small number of closely interconnected activities.

A number of organisations also encountered barriers as the change process they had adopted either didn't fit with their strategic intent or was inappropriate for their work environment. Edgell Bird's Eye and Pacific Dunlop Bedding were examples of firms encountering these difficulties. Both introduced relatively prescriptive change processes that didn't address a number of site specific issues. As a consequence the change processes were modified considerably during implementation and momentum and enthusiasm were dissipated. Moreover, some other firms developed effective plans but were unable to implement them effectively. Du Pont's change process stalled because the change champion resigned and a suitable replacement could not be found. Pampas' change process lost direction because the change process became contaminated with an award renewal process. The change champion was heavily involved in renegotiating award entitlements and many award personnel were unsatisfied with the outcome. Consequently, support for the program and change champion was withdrawn. Edgell Bird's Eye also abandoned a number of the elements of its change strategy midway through the change process and due to the interdependency between change activities, the remaining elements were unable to be progressed satisfactorily. Murray Goulburn's change process stalled because the CEO retired midway through the program and his replacement did not fully support the change process. Finally, a number firms achieved short term gains, during or shortly after change activities were completed but have been unable to sustain them. Smorgons' viewed its change process as a "one off" activity rather than a catalyst to promote ongoing change. Consequently, all funding and resources were withdrawn when
a number of particular activities were completed and the firm quickly reverted to the "old ways" of operating. Don also made extensive use of consultants in its change process who became defacto change champions. The consultant’s contract expired before a critical mass of employee support had been gained and consequently many gains were lost. Kellogg lost valuable ground also because existing human resource management practices, eg. recruitment, training, development and remuneration did not support the new ways of working.

Table 5.12 lists these 5 principal barriers, key contributing barriers and the main effects observed. The list of contributing barriers given here is not exhaustive with the 10 most common barriers (refer Figure 5.11) listed.

5.7 Chapter Summary

This chapter has provided a discussion of the results of the qualitative analysis. Section 5.2 provided a discussion of key change drivers and barriers to change. It was shown that firm’s rationale for change varied widely with typical reasons including improve quality, reduce cost and survival. Site change environments were also shown to vary substantially across sites. Key differences included the degree of past exposure to change, industry and market volatility, quality of the employee/employer relationship, workload, retrenchments, literacy and labour turnover. Various cases were discussed to illustrate that:

- different performance and competitive issues had a substantial impact on the change drivers and therefore objectives of the gap closing strategy (i.e. IM and practice investments) developed at each site.
- different change environments meant that different issues and barriers needed to be addressed and overcome and this also had a significant impact on the gap closing strategy developed at each site.

Section 5.3 provided a discussion of the strategic management processes adopted by each of the twelve firms. All firms studied used planning processes consisting of three key stages. The first, or NOW stage, consisted of an initial review of operations using some form of analysis or diagnostic. The second, or WHERE stage, defined the future state, typically in the form of a business mission, business objectives (growth, profitability etc), philosophy statement, core competencies and functional strategies. The third, or HOW stage, sometimes defined as the change plan, consisted of the detailed set of objectives, action plans, interventions and measures used to achieve the future state. The process was illustrated by discussing one firm, Kellogg’s, change process in detail and illustrating differences in other firm’s approaches through a number of variations.
<table>
<thead>
<tr>
<th>PRINCIPAL BARRIER</th>
<th>CONTRIBUTING BARRIERS</th>
<th>EFFECTS</th>
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<tbody>
<tr>
<td>• Lack of real pressure for change</td>
<td>• Entrenched I.R. attitudes and tensions</td>
<td>• Change process abandoned</td>
</tr>
<tr>
<td>• Employees don't understand / accept company direction</td>
<td>• Poor communications</td>
<td>• Minimal improvement in performance</td>
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<tr>
<td>• Ineffective or inappropriate change plan</td>
<td>• Fast pace of reform</td>
<td>• Practices slow to develop</td>
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<tr>
<td>• Inability to implement change</td>
<td>• Heavy workload / insufficient resources</td>
<td>• Fad surfing</td>
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<tr>
<td>• Inability to develop work environment to institutionalise change</td>
<td>• Retrenchment / down sizing</td>
<td>• Lack of critical mass of employee support</td>
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<td></td>
<td>• Geographically dispersed resources</td>
<td>• Conflict</td>
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<tr>
<td></td>
<td>• Excessive focus on short term issues</td>
<td>• Gains aren't sustained</td>
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<td></td>
<td>• Fear of failure</td>
<td>• Employees reluctant to become involved</td>
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<td></td>
<td>• Organisational norms</td>
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Section 5.4 provided a discussion of the actual change activities that occurred at the various sites. As significant variations were noted in terms of what interventions and practices were used and in what sequence, who was involved and why and how they were involved, three cases Kellogg, Fibremakers and South Pacific Tyres were discussed in considerable detail and the remaining cases used to enrich aspects of the various discussions. The discussion of these three principal cases demonstrated the different ways that firms can approach the use of AMT, JIT and TQM. These discussions also served to further illustrate the impact of differing rationale for change and change environments on the change activities that occurred within each firm.

Section 5.5 presents a discussion of quantitative and qualitative outcomes. The list of quantitative outcomes is long and varied being somewhat dependent upon the change drivers, change environment and type of technological, organisational and human resource investments made. Outcomes observed include increased technological competitiveness, increased processing capacity, improved customer focus, reduced processing time, reduced materials costs, increased productivity, reduced labour and increased manufacturing costs. All sites implemented TQM and therefore, as expected, all sites indicated improvements in quality and workforce skills. Nine sites introduced AMT, however, only seven reported the outcome “leading edge of manufacturing technology”. The reasons for these two exceptions was also explained. Five firms implemented JIT and outcomes were mixed as different firm’s introduced different JIT practices to address different operational needs. In respect to qualitative outcomes, all firms indicated that the change process had a positive effect on internal relationships and all firms, except Smorgons, reported extensive use of teamwork. It was discussed how care needs to be taken in interpreting these results. For example, the process for awarding the Best Practice grant, the formation of the site consultative committees and other external considerations, such as the recession and retrenchments, affected the employee/employer relationship. Finally, although all firms had implemented TQM, two firms indicated that the qualitative outcome, increased customer focus, was not an outcome of the change process. Also, only a relatively small number of firms indicated that the change process had improved the alignment between employee and stated company values and increased employee’s acceptance of change. These outcomes were discussed in some detail.

The final section, Section 5.6, presented a discussion of the barriers to change that different firms encountered at three different stages of the change process, commencement, implementation and completion. For the 12 organisations studied it appears that two different types of change barriers were experienced: principal and contributory. Many different contributory barriers were observed including entrenched industrial relations attitudes, poor communications, heavy workload and retrenchment but only 5 principal barriers were found. These were: lack of real pressure for change, lack of acceptance of the direction for change, ineffective or inappropriate change plans, an
inability to implement change and an inability to develop work environments to sustain improvement. The five principal barriers were illustrated through consideration of the 12 case studies.
DISCUSSION

6.1 Introduction

The previous two chapters described the results of the quantitative analyses (Chapter 4) and qualitative analyses (Chapter 5) used to test the propositions and address the questions posed in this research. This chapter is concerned with developing detailed insights into these results; combining the key findings from a number of different perspectives to enrich understanding of IM facets (hard AMT\(^1\), JIT, TQM) and practices and understanding of their relationship to measures of performance, comparing and contrasting the results obtained in the quantitative and qualitative analyses and relating findings to previous works. Contributions to the literature, practical implications, methodological implications, limitations of the research and future research implications are then developed in Chapter 7. The remainder of the chapter is organised as follows. Section 6.2 discusses the major results of the quantitative analysis in 4 main sections:

- Employee performance and manufacturing performance (Section 6.2.1),
- IM facets and employee and manufacturing performance (Section 6.2.2),
- IM facets and practices (Section 6.2.3),
- IM facets, practices and employee and manufacturing performance (section 6.2.4).

These discussions are enriched throughout by the inclusion of key findings from the qualitative analysis and the liberal use of references from other published works. Section 6.3 provides further discussion of the results of the qualitative analysis. This section is primarily concerned with the relationships between IM facet and practice investments and improvements in manufacturing performance and competitiveness. It is not concerned with further amplification of the discussions related to change processes or quantitative proposition sets as these are adequately discussed elsewhere. Section 6.4 provides a summary of the material discussed in this chapter.

6.2 Discussion : Quantitative Analysis

The following sections present a discussion of the key results from the quantitative analyses. Our lens of enquiry emphasises the IM facets of AMT and TQM. AMT is emphasised because of its failure to contribute to manufacturing performance and its relatively small

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\(^1\) In this chapter hard AMT is referred to as AMT.
contribution to employee performance. TQM is also emphasised as it was found to be the IM facet that was used most extensively (supported by quantitative and qualitative data) and has the largest associations with both employee and manufacturing performance. Further, many of the findings that relate to TQM apply to JIT due to similarities between the constructs and management approaches used.

6.2.1 Employee and Manufacturing Performance

<table>
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<td>• Moderate positive correlation between employee and manufacturing performance.</td>
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The moderate association between employee performance and manufacturing performance \((r = 0.647, p < 0.0001)\) was clearly demonstrated in this work. If we assume that improvements in employee performance lead to improvements in manufacturing performance, then this finding has important implications for firms in terms of the approaches taken to the selection, training and development of employees and the identification and implementation of practices that create work environments that maximise the value of employee contributions. It should be acknowledged however, that this high correlation could, at least in part, be due to other cause and effect relationships. For example, “better” employees may well be attracted to “better” performing manufacturing firms given the direct relationship between firm profits and the availability of slack resources for employee remuneration and investment in human resource development (Gerhart and Milkovich, 1992). Also investments in IM facets and practices may simultaneously increase both employee performance and manufacturing performance.

However, although these and other effects may be possible, there is a dearth of opinion amongst researchers to suggest that employee performance has a substantial impact on manufacturing performance. For example, Stalk, Evans, and Shulman (1992), and Pfeffer (1994), argue that as sources of competitive advantage such as protected markets, access to finance, economies of scale etc continue to become less important, the crucial factors in differentiating firm performance will become people and how they work. There is also evidence to suggest that in some firms this has already occurred. The sustained superior performance of firms such as Marriott, Borg Warner and Merck has been attributed to the capabilities of their employees and the use of human resource systems that facilitate the application of these capabilities for competitive advantage (Ulrich and Lake, 1990). Also managers are, in general, experienced, rational and of high intellect. It is therefore doubtful if these individuals would invest in human resource management practices if employee performance did not have a positive effect on manufacturing performance. Further, the empirical work of Denison (1982),
demonstrated that improvements in manufacturing performance lag organisational investments by 2 to 3 years, thereby contradicting the proposition that manufacturing performance leads to improvements in employee performance.

The case studies conducted as part of this research also suggested that improved employee performance can lead to improved manufacturing performance. Consider ANM, Fibremakers, Du Pont, Kellogg and Smorgons. These firms all compete in mature industries (paper/pulp, textiles, chemicals, food processing and basic metal products) which are characterised by intense competition, minimal barriers to entry, little or no proprietary technology, many substitute products and in some instances, eg. textiles and paper, horrendous losses and widespread bankruptcy (Standard and Poor's Industry Profiles, 1994). Consequently, these firms fare particularly poorly against Porter's (Porter, 1985) five fundamental competitive forces determining firm profitability: entry of new competitors, threat of substitutes, bargaining power of suppliers, bargaining power of buyers and rivalry amongst existing competitors.

Historically the business strategies of these firms emphasised increased market share and economies of scale. However, changing market characteristics and customer preferences have substantially diminished the value of this approach. For example, the textile industry traditionally competed on the basis of price and consequently Fibremakers, a supplier of nylon and polyester made large stocks of standardised products. With major clothing manufacturers and retailers wanting to stock leaner inventories and be more responsive to changing customer tastes and competitor movements, the basis of competition has shifted to responsiveness to order. As remarked by Fibremaker's CEO:

"20 years ago quality and delivery didn't matter as much as unit cost. Our order to delivery time used to be 40 days. Today it's 14 days and by the turn of the century we estimate it will be 4 days. In this industry time and flexibility are becoming more critical than cost."

ANM, Fibremakers, Du Pont, Kellogg and Smorgons have no structural advantages, and possibly some structural disadvantages. Consequently, their business strategies and change processes have emphasised human resource origins of competitive advantage: the creation of work environments that maximise the value of employee contributions to manufacturing performance. Hence the direction of the cause and effect relationship between these constructs, at least in intent, is clearly established. During the last decade all 4 firms have made substantial investments in their human resources and organisations. Moreover, these firms have developed measurement systems that clearly showed how investments in employee attitudes, skills and abilities and the work environment led to improved employee productivity which in turn led to improvements in manufacturing performance. Reported
improvements and the principal direction of causality were also confirmed during site interviews. Further, during this period of substantial change, staff numbers reduced substantially within all 5 firms through the mechanisms of retrenchment and attrition and minimal external recruitment occurred. Remuneration packages and general conditions of employment have also remained broadly aligned with industry norms. There was therefore no evidence to support that manufacturing performance may affect employee performance by attracting “better” performing employees into the organisation. Rather, there was considerable evidence to support the proposition that improvements in employee performance lead to improvements in manufacturing performance. This proposition was also reflected in the logic underpinning the outcomes hierarchy of the Best Practice Demonstration Program (Australian Manufacturing Council, 1994B, pp. 4). Consequently, in the remaining sections of this chapter we assume the principal direction of causality between IM facet and practice investments and employee and manufacturing performance is as follows. IM facet and practice investments lead to improvements in both employee performance and manufacturing performance. Improvements in employee performance lead to improvements in manufacturing performance. It is accepted that, in practice, other effects, including reverse effects, do exist but these are considered to be of second order magnitude.

In respect to the strength of association between employee and manufacturing performance, it should be noted, however, that the management actions of retrenchment, outsourcing, supplier rationalisation, contractor rationalisation and overtime reduction which occurred at many of these sites during this period have also contributed to improved manufacturing performance.

6.2.2 AMT, JIT, TQM and Performance - General

Findings:

- AMT, JIT and TQM are positively related to employee performance.
- JIT and TQM are positively related to manufacturing performance.
- Stronger associations between IM facets (AMT, JIT and TQM) and employee performance than IM facets and manufacturing performance

IM Facets and Employee and Manufacturing Performance: General

The results of MULTIPLE REGRESSION indicated that the three factors AMT, JIT and TQM explain 31% of the variance in employee performance with TQM (beta = 0.511**) having the greatest effect followed by JIT (0.224**) and AMT (0.071*)³. The results of MULTIPLE

² ** denotes significant at p < 0.05.
³ * denotes significant at p < 0.10.
REGRESSION also indicated that the two factors, JIT and TQM, explain 19% of the variance in manufacturing performance with TQM (0.412**) having the greatest effect followed by JIT (0.272**). AMT was not associated with manufacturing performance at the 0.10 level of confidence.

The finding that AMT is associated with employee performance but is not associated with manufacturing performance is consistent with the findings of Voss (1988a, b). He found that firms gaining benefits from AMT’s are more likely to experience productivity improvements rather than business benefits such as improved quality, reduced lead times and greater flexibility. This finding is also consistent with that of Ettlie and Reza (1992), who argued that manufacturing firms often derive value from process innovation (eg AMT) by making it a “unique occasion for organisational restructuring”. They note that this can yield benefits that include improved employee productivity and enhanced supplier co-ordination. The case studies conducted as part of this research provided partial support for these findings. For example, Edgell Bird’s Eye, Kellogg and Smorgons principally introduced AMT to improve organisational effectiveness. Consequently, significant emphasis was placed on using technology as a vehicle to effect culture change. Many organisational interventions accompanied the introduction of AMT with a view to developing the business awareness, teamwork and distributed leadership capabilities at these sites. Alternatively, Pampas and Du Pont principally introduced AMT to develop strategic capabilities. Pampas emphasised improved product quality and Du Pont, responsiveness to order. In these two cases, employee’s indicated that AMT had a positive effect on manufacturing performance. As Pampas and Du Pont had also introduced many other interventions, for example TQM, teams and planning, it was not possible to assess the degree to which improved manufacturing performance was, or was not, associated with the introduction of AMT. It should also be noted that the manufacturing performance construct used in this research does not include perspectives such as flexibility, responsiveness, market image etc. Consequently, if these are key objectives for AMT implementation, it is possible that an association between AMT and manufacturing performance exists but was not detected due to the measurement scales used.

The results of the MULTIPLE REGRESSION analyses also suggest that application of TQM and JIT can effect improvements in employee and manufacturing performance with TQM having a greater effect in both performance areas. Again caution needs to be exercised in respect to issues of causality as better performing firms may have a greater disposition toward TQM and JIT investments although as indicated earlier, there is some evidence to suggest that this is not the case. Also, the high degree of association between employee and manufacturing performance will influence the magnitude of the associations observed. For example, TQM may improve employee performance by enhancing job variety and recognising individual
contributions and this may contribute to the development of the set of behaviours (eg. customer oriented mindset) that lead to improvements in manufacturing performance. Alternatively, TQM may act to directly reduce waste, rework and unit costs resulting in improved manufacturing performance and this in turn, may lead to additional human resource investments (eg. training), further workforce empowerment and the recognition of employee contributions leading to improved in employee performance.

The case studies conducted also provided strong support for the value of TQM as an effective technology to improve both employee and manufacturing performance. The comments of a work group co-ordinator at Du Pont typified those of many sites:

"TQM was the first activity to really involve people. It came at a time when the business was struggling and gave us some practical tools to make improvements. The more we showed that we could implement changes which improved company performance, the more responsibility the company gave us and the better we felt about our jobs."

As all firms studied had implemented strong TQM environments, it was not possible to evaluate the impact of the strength of the TQM environment on employee and manufacturing performance. Notwithstanding this general comment, some firms, notably Australian Newsprint Mills, Pampas and Pacific Dunlop Bedding indicated that TQM had fallen short of expectations. Management representatives of these firms indicated that the TQM philosophy was predicated on the assumption that the workforce was accepting of authority, direction and change and this limited its effectiveness in the Australian workplace. Under the umbrella of TQM, Australian Newsprint Mills, Pampas and Pacific Dunlop Bedding had made substantial investments in the areas of skills, strategies, structures, processes and systems with a view to creating work environments where employees were encouraged to accept additional responsibility and align their efforts with the super-ordinate goal of quality improvement. There was general agreement amongst these firms however, that TQM's mechanistic approach failed to adequately address issues of workforce behaviour and resistance to change (site culture, entrenched employee attitudes, low trust, poor co-operation etc) and as a consequence envisaged gains were often not realised.

**1M Facets and Employee and Manufacturing Performance : Strength of Association**

The generally stronger level of association between 1M facets and employee performance than between 1M facets and manufacturing performance provides some support for the view that 1M facets are more effective at changing workplace culture than improving manufacturing performance. Further longitudinal studies would need to be conducted to prove or disprove this proposition as at it is acknowledged (Denison, 1982, AMC, 1994B) that...
improve me nts in workpl ace cultur e lea d improve me nts in ma nufactur in g performanc e by 2 to 3 years and the 12 firms studied had generally been pursuing Best Practices for a relatively short period of time.

The existence of stronger associations between IM facets and employee performance (than between IM facets and manufacturing performance) is also consistent with the observation that IM facets are underpinned by human resource theories of competitive advantage (Schuler and Jackson, 1987, Samson, Sohal and Ramsey, 1993, Lado and Wilson, 1994, Pfeffer, 1994, Wright, McMahon and McWilliams, 1994, Snell and Youndt, 1995). That is, firms embracing AMT, JIT and TQM accompany these investments with streams of investments in employees and the work environment to develop long term, human resource based, competitive capabilities. Areas of employee development include technical, interpersonal and business skills and alignment of employee behaviours and attitudes with espoused company values. Areas of work environment development include structure (organisational and work group), team and individual roles and responsibilities, policies and procedures, measures and systems. These developments are combined and applied in various ways to develop a specific set of human resource based order winning capabilities.

The 12 case studies indicated that the majority of those sites invested in IM facets firstly, to develop human resource based competitive capabilities (eg. shared strategic intent, distributed leadership and collaborative supplier relationships) and secondly, to deliver short term improvements in manufacturing performance (reduced labour, improved product quality, improved workforce productivity). It is noteworthy that the emphasis placed by these firms on the development of human resource based competitive capabilities is also biased, to some extent, by their participation in the Best Practice Demonstration program. Firms were awarded grants on the basis of the potential of their change processes to act as demonstration models for Australian industry. Applications that emphasised new ways of working and increased competitiveness therefore provided a greater opportunity for learning and had a greater likelihood of success than those that emphasised improvements in outcomes.

6.2.2.1 AMT

Findings:

- AMT is positively related to manufacturing performance but only in a strong TQM environment.
- The interactive term AMT * TQM is positively related to both employee and manufacturing performance
- Firms weak in AMT, JIT and TQM have stronger manufacturing performance than firms weak in JIT and TQM but strong in AMT.
The greater the investment in AMT the weaker the correlation between employee and manufacturing performance.

The combination of JIT, TQM and the seven practices have a stronger association with both employee performance and manufacturing performance in stronger AMT environments.

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<th>AMT is positively related To Manufacturing Performance but only in a strong TQM environment</th>
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The finding that AMT is associated with manufacturing performance but in a strong TQM environment lends support for the view that new technology increases, rather than decreases, the need for a skilled and committed workforce (Jaikumar, 1986). Increased technological sophistication requires a higher skilled workforce to operate the equipment and the high investment cost increases the cost of breakdowns and increases the need for operators to also acquire additional skills in fault finding and maintenance. As a consequence, organisations respond by adopting Zuboff's (1988) informating strategy and Wall, Corbett, Martin, Clegg and Jackson's (1990) operator control strategy (refer Section 2.7.1). These strategies are based on the principles of workforce empowerment and involvement, hallmarks of those organisations that embrace the TQM philosophy. The case studies supported this view as TQM investments accompanied AMT investments in all cases. However, it should be noted that the sample population is biased toward firms making investments in human resource management practices.

The finding that AMT contributes to manufacturing performance in a strong TQM environment is also consistent with two previous areas of research. First, Zammuto and O' Connor (1992), argue that many organisations derive value from AMT by using it as a unique opportunity to change organisational culture and as a result, improve their manufacturing performance. Looked at this way, AMT provides the opportunity to redesign work flows, roles, responsibilities, structure etc and thereby facilitate changes to employees routines, behaviours and mindsets. TQM is also widely acknowledged (Samson, 1991, Powell, 1995) as a key technology in the transformation of workplace cultures. Consequently, it is expected that the ability of TQM to effect changes in workplace culture will be enhanced in a strong TQM environment. The case studies conducted as part of this research also support this argument. Most firms embracing the TQM philosophy were also pursuing culture change. Consequently, firms embracing TQM are more likely to make (the necessary) organisational adjustments when AMT is introduced and therefore gain value from their investment. Second, Zairi (1993), and Balan (1994), found that strong TQM environments exhibited many characteristics that supported the implementation of AMT and increased the probability that AMT investments yielded envisaged manufacturing performance improvements such as reduced lead times and
increased operating flexibilities. These characteristics included: effective strategic planning and consultative processes, a preparedness to invest in human resources and delegate responsibility and an ability to implement change. Zairi also indicated that a TQM environment supported AMT investments as many AMT projects were introduced with the objective of improving product quality. Case studies also provided some support for these arguments, in particular, the relationship between AMT investment and strategic planning activity was strong in all cases. Each firm’s technology strategy was defined in terms of the competitive needs of the business and as a consequence AMT installations were generally observed to be utilised to their maximum potential. The Australian Manufacturing Council (1994B) also reported insufficient planning as the key reason why new technological investments were either lying idle or underutilised within manufacturing plants.

The interactive term AMT * TQM is positively related to both employee and manufacturing performance

The association of AMT with manufacturing performance in a strong TQM environment was also supported by the addition of interactive terms to the MULTIPLE REGRESSION analyses. The interactive term AMT * TQM explained additional variance in both employee and manufacturing performance (refer Table 4.6). No other interactive terms (2 or 3 way) were significant.

Firms weak in AMT, JIT and TQM have stronger manufacturing performance than firms weak in JIT and TQM but strong in AMT.

By calculating the 33% and 67% breakpoints for each IM facet, the mean value of manufacturing performance was calculated in 27 different AMT, JIT and TQM environments. The need to accompany AMT investments with investments in other IM facets (JIT and TQM) was also demonstrated by the results of this analysis which showed that the weakest mean value of manufacturing performance was found in environments strong in AMT but weak in TQM and JIT. The difference in mean value of manufacturing performance for the group weak in JIT and TQM but strong AMT was statistically different (at the 0.05 level of confidence) from the group weak in AMT, JIT and TQM. Put differently, those firms that make a significant investment in AMT but chose not invest in JIT and TQM have a weaker manufacturing performance than those that do not invest in AMT, JIT or TQM. Other researchers have also indicated that AMT can have negative effects on manufacturing performance. A British Management Institute’s Survey of 239 companies found that 46% of firms considered that they had obtained a poor or negative return on their investment in computer aided design and computer aided manufacturing technology, figures that rose to 67% for flexible manufacturing.
systems and 76% for robotics (reported in Primrose, 1988). The survey also concluded that the main barriers to the effectiveness of AMT were organisational making particular mention of concerns with structure, goal clarity and culture. Majchrzak (1988), estimated the failure rate of US firms in the 50 to 75 percent range. Consistent with these findings De Meyer, Nakane, Miller and Ferdows (1989), also found that successfully implementing AMT was among the top concerns of senior manufacturing executives in US and European companies. Although it is widely acknowledged that in some instances, AMT does have a negative impact on manufacturing performance, researchers have not generally focused their efforts on the impact of JIT and TQM environment on the probability of AMT success.

The greater the investment in AMT the weaker the correlation between employee and manufacturing performance.

By their nature IM facet investments are based on human resource management theories of competitive advantage (Ramsey, Sohal, and Samson, 1990). Consequently, it was expected that firms introducing AMT, JIT and TQM would not only support these investments by an accompanying set of investments in organisational practices, (Dow, Ford and Samson, 1996) but that collectively, these investments would combine synergistically to improve manufacturing performance. Therefore, in strong AMT environments, employee performance was expected to explain a greater degree of variance in manufacturing performance than in weak AMT environments. This was not found to be the case. The strength of AMT environment was found to be negatively associated with the correlation between employee and manufacturing performance. Although unexpected, this result is consistent with the findings that AMT is positively associated with employee performance, AMT has no association with manufacturing performance and employee performance drives, rather than is driven by, manufacturing performance. Increased strength of AMT environment is associated with a small increase in the mean value of employee performance but has no statistically significant effect on the mean value of manufacturing performance. Consequently although stronger AMT environments are associated with better employee performance, this is not able to be translated into better manufacturing performance and hence the association between employee and manufacturing performance is weaker. Three reasons are given for this finding.

First, AMT investments are not associated with practice environments that are positively associated with employee and manufacturing performance. Rather, the practice most strongly associated with AMT is benchmarking which has a small negative association with manufacturing performance (-0.049) although this is not significant at the 0.10 level of confidence. Further, those practices most strongly associated with employee performance are HR management, leadership and planning and these three practices have very weak
associations with AMT. Consequently, AMT investments are only very weakly associated with practice investments in areas that increase employee performance, but rather, have the strongest association (0.229**) with the practice of benchmarking which has a tendency toward negative association with manufacturing performance. The logic underpinning the proposition therefore does not hold. It was difficult to assess these considerations in the case studies as all firms implemented strong human resource management platforms in conjunction with AMT investments. Smorgons, however, indicated that AMT investments at their site were accompanied with training but organisational investments such as organisation, work and job redesign design did not occur until 18 months to 2 years later. During this interim period employee morale improved somewhat but manufacturing performance had not. A supervisor at Smorgon remarked:

“I remember when we first introduced new technology...there was a real hype around the place and people really lifted...it was the first major investment in 20 years. But everyone’s jobs stayed the same and we had real quality and waste problems. Everyone was doing their own thing and no-one knew who was responsible for what. We were all really busy trying to get the plant to work but with little co-ordination and virtually no internal co-operation nothing got resolved.”

Second, AMT might strengthen other drivers of manufacturing performance not included in the MULTIPLE REGRESSION equation and therefore effectively reduce the contribution of employee performance. (The factors used in the MULTIPLE REGRESSION equation explain only 25% of the total variance in manufacturing performance.) Effects need to be small otherwise a direct positive association between AMT and manufacturing performance would, in all probability, be found. Case studies indicated that some firms were introducing AMT’s to improve key drivers of manufacturing performance that did not directly involve the main body of their workforce. For example, Du Pont introduced information technology to improve the integration of customers into the planning cycle. This technology led to a better understanding of customer needs and gaps in customer service. As a consequence of deficiencies and shortcomings revealed by this technology, a number of forums were convened with major customers and potential customers. The outcomes of these forums included re-engineered business processes, amended product specifications and long term customer service agreements. Du Pont believe that the closer relationship with customers, facilitated by the introduction of AMT, have become a key source of competitive advantage. Consequently, it is expected that by developing a source of competitive advantage not directly involving mainstream employee contributions, AMT has weakened the general strength of association between employee performance and manufacturing performance.

Third, the negative association may also be associated with the questions used to form the AMT construct. Specifically, stronger AMT environments are not necessarily reflected in
stronger values of the AMT construct as the construct measures a hybrid of strength and perception of value. If respondent's score the questions that comprise the AMT construct high it is possible that the firm has made a small AMT investment that is perceived to have a high impact on manufacturing performance. These effects may significantly influence the results obtained and account, at least in part, for the negative association observed.

The combination of JIT, TQM and the seven practices have a stronger association with both employee performance and manufacturing performance in stronger AMT environments.

AMT was also found to have a positive effect on the association between other IM facets and practices and employee and manufacturing performance. The results of two separate MULTIPLE REGRESSION analyses with employee and manufacturing performance as the dependent variable and using JIT, TQM and the seven practices as independent variables, showed that the MULTIPLE REGRESSION equations explained considerably more variance as the AMT environment increased in strength. Table 6.22 shows this trend. The predictive power increased by 28% for manufacturing performance and 25% for employee performance. This implies that although AMT may have no effect on manufacturing performance and only a small influence on employee performance, AMT environment serves to increase the strength of the relationship between the other IM facets and practices and manufacturing and employee performance. This is an interesting and key finding. Most previous researchers have considered the relationship between AMT and organisational investments from the perspective of AMT, regarding investments in organisational and human resource areas as a necessary concomitant for AMT success (Gold, 1982, Goldhar and Jelinek, 1983, Jelinek and Goldhar, 1984, Balan, 1994). This finding considers the complimentary view. That is, as AMT investments often effect most, if not all areas of the organisation they have the potential to create a single focus and common platform from which to implement and integrate human resource and organisational investments. Used in this way AMT enhances the value of these investments to the organisation. The case studies at South Pacific Tyres and Kellogg strongly supported this finding. In these cases the new technology affected many aspects of the organisation and most of the employees that worked within it. AMT helped employees to understand and accept the need for change in the workplace, and therefore the need for organisational and human resource investments, as people could see the impact of the new technology through prototype machines, presentations, video productions and site visits. As a consequence, mindsets gradually shifted from preservation of the past to acceptance of company direction. Key areas of change included structure and work groupings, overtime and hours of employment, roles and responsibilities, systems and procedures, goals and objectives and skills and knowledge. Employees had a greater say in issues that affected them,
responsibilities were enhanced and job variety enriched. Moreover, the retirement of the old technology meant that it was not possible to revert to the old ways of working, and as a consequence improvements were firmly anchored. The change environment created by this new technology also served to give organisational and human resource investments legitimate organisational status. Employees regarded them as essential, rather than "nice to have", as they were necessary in order to perform their new roles and enable the equipment to operate as intended. Therefore, as a consequence of an AMT platform, workplace investments had a considerable positive and sustained impact on employee and manufacturing performance at these sites.

6.2.2.2 TQM

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<th>Findings:</th>
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<td>TQM is a stronger differentiator of performance between groups with low/medium levels of manufacturing performance than between groups with medium/high levels of manufacturing performance.</td>
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<tr>
<td>TQM is a stronger differentiator of performance between groups with low/medium levels of employee performance than between groups with medium/high levels of employee performance.</td>
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<tr>
<td>The correlation between employee and manufacturing performance does not increase with strength of TQM environment.</td>
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*Predictive Power of TQM: The Impact of Performance Environment*

When two discriminating functions are formed: one discriminating low from medium manufacturing performance, the other, medium from high manufacturing performance and AMT, JIT, TQM and the seven practice constructs used as independent variables, differences in the relative associations, and therefore value, of the independent variables can be made. The canonical correlation coefficients are similar in both cases: 0.482 low/average and 0.450 average/strong indicating that the combination of independent variables explains approximately the same degree of variance in manufacturing performance in both case. However, TQM explains 45% of the variance (of the discriminant function) for the low/medium manufacturing performance case and only 22% of the variance for the medium/high manufacturing performance case.

The same analysis was repeated for employee performance using the same set of independent variables and a similar result obtained. The canonical correlation coefficients were again similar in both cases: 0.621 low/average and 0.563 average/strong. TQM explained 49% of the variance (of the discriminant function) for the low/medium employee performance case.
and only 24% of the variance for the medium/high employee performance case.

These results show that for the dependent variables of employee performance and manufacturing performance, the explanatory power of TQM is (approximately) halved when weak/medium performance environments are compared to medium/strong performance environments.

The case studies provided substantial information to support this decrease in value of TQM with increasing levels of performance. All 12 firms studied had implemented TQM and all indicated that TQM was an important ingredient to breaking out of the insular production driven mindset that dominated manufacturing during the 1970's and early 1980's. Different firms cited different benefits. Some indicated that TQM was of considerable value in catalysing the start of the employee empowerment process. Some indicated that the accompanying set of TQM tools and techniques, for example, process mapping, measurement, cause and effect diagrams, affinity diagrams, pareto diagrams, PDCA cycle etc enabled a more systematic and structured approach to quality improvement to be introduced. Others indicated the value of TQM in obtaining a definitive understanding of customer requirements and developing quality as a core organisational value. However, there were signs that TQM's value had diminished in a number of organisations and that quality was becoming a qualifier, rather than discriminator, of manufacturing performance. As noted by the change champion at Kellogg:

"TQM was probably the most important building block we put in place. It helped us to open the door to the development of a service culture, got people thinking about a different way of working and gave us some practical tools to improve quality and reduce waste. But everyone's into it today and it's relative (competitive) value is greatly diminished."

A senior manager at Du Pont also remarked:

"TQM was important. It helped us make a number of changes to improve our performance: Customer service standards, quality strategies, quality accreditation, quality procedures, customer first teams and strategic business units were all introduced as part of this process...but it only takes you so far. We realised that it was not an effective technology for developing workplace culture. It alluded to the value of leadership, management style, empowerment, shared values and the like...but it didn't really give you much guidance on how to go about them... what it did give took too long."

This sentiment, that quality was becoming "a qualifier for doing business rather than discriminator of business performance" was also noted in case studies performed at other locations (Challis and Samson, 1996B).
The Impact of strength of TQM environment on the association between employee and manufacturing performance

The failure of TQM environment to explain additional variance in the employee performance/manufacturing performance relationship may also be related to its reduced explanatory power in stronger employee performance and manufacturing performance environments. It is possible that greater investments in IM facets and practices collectively increase the value of employee contributions to manufacturing performance (and therefore the magnitude of the correlation between employee and manufacturing performance) but that TQM in isolation, explains insufficient variance in employee performance to determine this relationship.

The case studies, however, provided some information to support the general proposition that the stronger the platform of IM and practice investments the stronger the association between employee performance and manufacturing performance. Of the 12 firms studied, Kellogg, Du Pont and Pacific Dunlop Bedding had made the largest investments in human resources and organisational practices. These firms had also identified the set of core capabilities needed to be developed to secure their future. These capabilities, for example, the development of collaborative relationships with suppliers and the seamless transfer of information between engineering and operations were bedded in the concepts of continuous improvement, organisational learning and human resource based theories of competitive advantage. Consequently, manufacturing performance was very strongly driven by employee performance. As remarked by a senior manager at Pacific Dunlop Bedding:

“*We view the changes made in the workplace as investments in our future. I have no doubt whatsoever that these investments accumulate to make us more competitive and that at the end of the day, our only real source of competitive advantage will be our ability to capitalise on the talents of employees.*”

We discuss these perspectives further in Section 6.3.

6.2.2.3 JIT

General comments and observations relating to JIT, its associations with practices and employee and manufacturing performance are included throughout this chapter. In general, JIT exhibits many similarities to TQM, exhibiting positively associations with employee and manufacturing performance, although the effects are less pronounced.

Case studies showed that JIT had generally been used to rationalise supplier and material arrangements and that substantial gains had often been achieved. Edgell Bird’s Eye
and Kellogg’s in particular (refer Chapter 5) remarked on the extent to which JIT had improved manufacturing performance by reducing lead times and materials costs and reducing investment in inventories and stocks.

Pacific Dunlop Bedding’s JIT experiences also served to illustrate that in a poor industrial relations environment, JIT can act to worsen manufacturing performance. As remarked by the change champion at this site:

“JIT removes all the buffers and makes you much more vulnerable to the effects of employee actions. We had a demarcation dispute in one small area of the plant and to protest against the actions of the company, the operators refused to work overtime. As a consequence we couldn’t service some parts of the plant and production had to be cut. We had a similar problem with maintenance...we’ve learned that JIT not only increases the responsibility of employees but it also increases their power.”

6.2.3 AMT, JIT, TQM and Practices

Finding:

- A Weak to Moderate Positive Association Between AMT, JIT, TQM and Practices

The results of the correlation analysis indicated the general weak to moderate and positive associations between IM facets and practices. Consequently, there is considerable support for the view that IM facets and practices are interdependent and hence, tend to appear in combination.

At the .05 level of significance, all practices were correlated with TQM. The strongest correlations were planning (0.434), leadership (0.366) and HR management (0.274). It is noteworthy that after the effects of IM facets are considered, these are the three practices with the largest association with employee and manufacturing performance (refer section 6.2.4). These three practices are key aspects of the Baldridge Quality Award Criteria and reflect the degree to which firm’s apply quality management concepts systemically. Moreover, strategic context, strong leadership and supportive HR policies have been argued by practitioners and researchers alike as key ingredients in the successful implementation of TQM (Samson, 1991).

The case studies conducted as part of this research also provided pockets of evidence to support these associations, in particular TQM and planning. All firms studied had implemented TQM and applied detailed strategic planning methodologies. The following comment from Du Pont, typified firms’ responses in this area:

“In the early days, TQM helped us to discover just how important it was to understand what customer’s want. For example, through detailed discussions with major users of our agricultural chemicals we gained a deeper understanding of the various uses and performance requirements...
of our products. We used this information to not only redefine product specifications, but to fundamentally rethink where this business was going. By using TQM to drive the development of new strategies in marketing, distribution and manufacturing, sales in the area have quadrupled."

Most firms also indicated the need for "strong and committed leadership" to drive the change process although a relative few, 4 of 12, had made direct investments in the leadership area. The majority of firms also emphasised senior management leadership and consequently strategic, long term perspectives such as building shared vision, overcoming resistance to change and, as remarked by the change champion at Australian Newsprint Mills "pushing it along when the going got tough" were emphasised. In 3 sites, all with entrenched adversarial industrial relations cultures the change process was led by a consultant who was appointed by the consultative committee. This was considered a key step in ensuring objectivity and gaining workforce acceptance of the change process. South Pacific Tyres, Fibremakers, Du Pont and Edgell Bird’s Eye and Don all indicated that their change processes were largely led by "champions of change", individuals who were not appointed or conscripted to the process but who believed in its ideals, were influential in the workplace and possessed the energy and enthusiasm to build acceptance for change and commitment to the process amongst the broader workforce. These leadership capabilities permeated all change activities at these sites. As remarked by the change champion at Edgell Bird’s Eye:

"Real change would not have occurred without these 4 shop floor operators who’ve been around a long time. They came on board early and were influential over their peers and prepared to speak up to management when it was needed. They were also unique individuals...exceptionally good communicators, energetic and people with high integrity who could keep their cool. I know the management team really respected their openness and candour."

Two firms, Du Pont and Kellogg also indicated that at their more advanced stages of development, middle management leadership capabilities were needed to progress aspects of their change process but that these were lacking. Du Pont’s CEO remarked:

"We’ve spent a lot of time at the top developing the leadership capabilities of senior executives in order to give the organisation direction. We’ve also invested significant resources at the bottom developing the leadership capabilities of teams to support continuous improvement and progress empowerment. However we’ve neglected the middle levels of the organisation who, to some extent, feel alienated in the change process and we’re finding that this oversight has created a real barrier."

HR policies were considered by a number of firms, notably Kellogg, Australian Newsprint Mills, Edgell Bird’s Eye and Pacific Dunlop as essential to consolidate and
institutionalise the gains achieved from the various investments introduced. Kellogg’s specifically mentioned the value of making investments in an appropriate set of recruitment, development and remuneration policies to support changes in the workplace. This finding is consistent with that of Snell and Dean (1992), who also found a positive association between TQM and investments in recruitment, training, development and remuneration practices.

At the .05 level of significance, all practices except the ability to change and training were correlated with JIT although correlations were considerably weaker than TQM. The three strongest correlations were: leadership (0.165), benchmarking (0.160) and teams (0.153). Qualitative studies indicated that many firms applied differing JIT practices. The most commonly observed practices across the 12 cases were rationalisation of suppliers, JIT purchase and delivery and instilling quality at the source. These activities were typically championed by representatives of the purchasing/procurement function with manufacturing personnel involved in a secondary capacity as required. The weaker levels of association between JIT and practices (compared to TQM) found in the quantitative research are therefore consistent with this observation as the types of JIT initiatives found in case studies are not mainstream to the manufacturing function where practices such as leadership and teams were concentrated. It is noteworthy that only 2 of the 12 firms studied had implemented Kanban/pull production scheduling systems.

At the .05 level of significance, benchmarking, teams, HR management and planning are correlated with AMT. The three strongest correlations are: benchmarking (0.229), teams (0.108) and HR management (0.089). The correlation between AMT investments and benchmarking was clearly demonstrated in the qualitative analysis. All firms that implemented AMT undertook detailed benchmarking activities at the commencement of the project to evaluate a range of aspects related to the technology, its impact on the organisation and its affects on business performance. However, in a number of cases benchmarking efforts were not institutionalised: that is, there were no protocols developed concerning benchmarking responsibility, frequency of occurrence, selection of partners, ethics and confidentiality and scope of activity. Rather, shifts occurred as experience with the technology, equipment and benchmarking partners was gained and differing issues and problems emerged. The qualitative analysis also provided evidence to support associations between AMT and team based work structures. The South Pacific Tyres case described in Chapter 5 discusses these linkages in some detail. However, care needs be exercised in interpreting associations between AMT and teams as it is difficult to separate direct interactions between AMT and teams from the effects of other interventions such as TQM and JIT. Also, the population of firms considered in the qualitative analyses were biased toward those using teams due to the criteria used to award Best Practice grants.
Findings:

- The practices of planning, leadership and HR management have moderate associations with employee and manufacturing performance.
- The practices of benchmarking and teams have weak, if any, association with employee and manufacturing performance.
- After the effects of AMT, JIT and TQM have been considered, practices account for additional variance in employee performance.
- After the effects of AMT, JIT and TQM have been considered, practices account for additional variance in manufacturing performance.
- Firms with strong manufacturing and strong employee performance do less benchmarking and have fewer teams than firms with weak manufacturing and strong employee performance.
- The practices of benchmarking and teams are positively related to the associations between JIT and employee performance and JIT and manufacturing performance.
- The practices of benchmarking and teams are positively related to the associations between TQM and employee performance and TQM and manufacturing performance.
- The practices of planning and training are positively related to the associations between AMT, JIT, TQM and manufacturing performance.
- The practices of benchmarking and ability to change are positively related to the associations between AMT, JIT, TQM and employee performance.
- The strongest correlation between practices and IM facets (aggregated) is found in firms with strong employee and weak manufacturing performance.
- The weakest correlation between practices and IM facets (aggregated) is found in firms with weak employee and strong manufacturing performance.

Associations Between Practices and Performance - General

At the 0.05 level of significance, all practices except benchmarking were correlated with employee performance. The strongest correlations were between HR management (0.398), leadership (0.394) and planning (0.275). At the 0.05 level of significance, all practices except benchmarking and teams were correlated with manufacturing performance. The strongest correlations were between HR management (0.278), leadership (0.242) and planning (0.175). Associations between practices and employee performance are also, in all instances, stronger than associations between practices and manufacturing performance adding further
support for the view (refer Section 6.3.2) that firms investing in practices and IM facets embrace human resource based theories of competitive advantage.

Practices were added as a separate step in the regression equations for employee and manufacturing performance and changes in variance examined. For employee performance the adjusted $R^2$ value increased from 0.317 to 0.463, an increase of approximately 46%. For manufacturing performance the adjusted $R^2$ increased from 0.208 to 0.251, an increase of approximately 20%. In both cases those practices explaining the most additional variance were planning, HR management and leadership. Consequently these practices not only support the use of IM facets, and vice versa, but of all practices, contribute the most to improved employee and manufacturing performance. Case study observations made in respect to the relationships between planning, leadership, HR management and performance were provided in the general discussion of associations between IM facets and practices in Section 6.2.3

**Benchmarking and Teams**

The results of the quantitative analysis also indicate that neither benchmarking nor teams were associated with manufacturing performance ($p < 0.10$). Benchmarking also has no positive association with employee performance with teams demonstrating a small positive association ($r = 0.103, p < 0.05$). Further, the differences in the mean values of the team and benchmarking constructs between the environments of strong manufacturing/strong employee performance and weak manufacturing/strong employee performance are statistically significant ($p < 0.05$). Specifically, firms with strong manufacturing and strong employee performance do less benchmarking and have fewer teams than firms with weak manufacturing and strong employee performance. These findings clearly cast considerable doubt on the value of benchmarking and teams in respect to improved manufacturing performance. However, although these practices have no positive association with manufacturing performance they clearly do have a positive impact on the association between JIT and TQM and manufacturing (and employee performance) and therefore serve to improve the effectiveness of these interventions.

First, consider associations with manufacturing performance. In weak benchmarking environments their is no statistically significant correlation ($p < 0.10$) between JIT and manufacturing performance whereas in strong benchmarking environments the correlation is 0.153**. In weak team environments there is no statistically significant correlation ($p < 0.10$) between JIT and manufacturing performance whereas in strong team environments the correlation is 0.990*. In weak benchmarking environments the correlation between TQM and manufacturing performance is 0.333** whereas in strong benchmarking environments the correlation is 0.412**. In weak team environments the correlation between TQM and...
manufacturing performance is 0.409** whereas in strong team environments the correlation is 0.433**.

Second, consider associations with employee performance. In weak benchmarking environments the correlation between JIT and employee performance is 0.124** whereas in strong benchmarking environments the correlation is 0.265**. In weak team environments the correlation between JIT and employee performance is 0.106* whereas in strong team environments the correlation is 0.265**. In weak benchmarking environments the correlation between TQM and employee performance is 0.301** whereas in strong benchmarking environments the correlation is 0.485**. In weak team environments the correlation between TQM and employee performance is 0.469** whereas in strong team environments the correlation is 0.487**.

There is no statistically significant association (p < 0.10) between AMT and employee or manufacturing performance in any benchmarking or team environment. Therefore, although benchmarking and teams have small, if any, statistically significant positive association with employee and manufacturing performance, in all cases, their presence serves to enhance the strength of the associations between JIT and performance and TQM and performance. There was some support in the case studies for these findings. We will consider the effects of benchmarking and team environment on the IM facet of TQM as the effects were the most noticeable (strongest associations) and widespread (TQM was used by all firms). As noted earlier, JIT and TQM are shop floor improvement philosophies underpinned by the principles of employee participation and empowerment and similar arguments can be developed for the associations between JIT and performance.

First, consider the impact of benchmarking environment. Australian Newsprint Mills, Exicom, Pampas, Pacific Dunlop Bedding, and South Pacific Tyres, were examples of firms whose TQM activities were strongly supported by benchmarking. Generally speaking, these firms used benchmarking to support TQM in two different ways. First, by providing information with which to direct shop floor improvement activity and second, by influencing employee attitudes toward change. Many sites specifically commented on the value of benchmarking information in ensuring that shop floor improvement activity added value to manufacturing performance. There was also general agreement amongst interviewees, both company and shop floor, that applied effectively, benchmarking helped to involve the workforce in the change process and support empowerment, leading to improved employee performance. A comment by Exicom's change champion summarised the role of benchmarking in supporting TQM activity within these organisations:

"If we didn't do benchmarking I'm sure the effectiveness of TQM would be greatly reduced. Most employees have spent their entire working life on this site...they generally didn't believe that
better ways of working existed or if they did, see why we should adopt them. By involving employees heavily in benchmarking we've been able to get them to understand why we need to change and identify real opportunities for improvement... to a large extent, our empowerment and continuous improvement processes are driven by benchmarking.

Teams were noted to have a similar effect on TQM effectiveness. As noted by the change champion at Don:

“Teams are the basic building block of our change process. They are equipped with the necessary resources to complete a defined chunk of work...responsibility shifts from tasks to outcomes. This not only also helps to create a customer focus, reduce waste and improve quality but it also helps to develop the level of co-operation and interdependency needed to drive continuous improvement from the shopfloor.”

The change champion at Smorgon also remarked:

“Benchmarking consistently showed that teams seemed to be the way to go. We kept seeing cellular work teams where a multiskilled group of people were responsible for an area of work. It appeared to us that teams provided more interesting work, generated improvement opportunities and helped to develop a quality culture.”

Pampas also found the introduction of teams to improve the effectiveness of TQM. Pampas introduced TQM within a traditional non-team based organisational structure and found that after an initial period of success, the program stalled for two key reasons. First, most improvement projects were generated, assessed and implemented by different individuals resulting in problems of co-ordination, co-operation and motivation. Second, many shopfloor employees lacked the necessary business insights with which to prioritise improvement opportunities. Consequently, a number of proposals were discarded by line management which frustrated shopfloor personnel, a number of whom subsequently withdrew from the TQM program. When Pampas redesigned jobs and work and introduced highly empowered, multi-disciplinary production teams, these concerns were largely eliminated. As a consequence both employee performance and manufacturing performance improved.

**The Impact of Practices on Associations Between IM Facets and Performance**

Returning to the quantitative analyses, the general impact of practice environment on the collective association between AMT, JIT, TQM and manufacturing performance and the collective association between AMT, JIT, TQM and employee performance was also assessed.

First, consider the major changes to manufacturing performance associations. In a weak planning environment AMT, JIT and TQM, collectively explain 14.4% of the variance in manufacturing performance whereas in a strong planning environment they explain 26.1% of
the variance. In a weak training environment AMT, JIT and TQM, collectively explain 15.1% of the variance in manufacturing performance whereas in a strong planning environment they explain 24.0% of the variance.

These general increases in strength of association are also, at least in part, supported by the case studies conducted. All firms studied had developed detailed strategic plans and consequently it was not possible assess the impact of a weak planning environment on AMT, JIT and TQM effectiveness. Change plans were generally implemented to close the gap between the existing state and the future state articulated in the manufacturing strategy. However the general level of difficulty encountered by firms in relating shopfloor improvement activity to manufacturing performance and maintaining organisational commitment to quality improvement initiatives would clearly be exacerbated by the lack of an effective strategic context in which to introduce IM facets. The need to integrate TQM into strategic management processes has also been identified as a key principal for its success (Ramsey, Samson and Sohal, 1991, American Society For Quality Control, 1993, Dow Samson and Ford, 1996). Ramsay, Sohal and Samson (1990), also found “thorough planning” to be the third most important factor in implementing and sustaining JIT and the Australian Manufacturing Council (1994), found that many sites experienced failure with AMT because technological investments occurred in the absence of effective strategic management processes.

All sites also invested considerable resources in employee training. Many different types of training were undertaken including: TQM and JIT tools and techniques, new technology training, functional training, performance measurement/benchmarking training, interpersonal skills training, team development training, business awareness and business skills training. Although there was considerable variation in individual’s assessment of the value of training, there was general agreement that training associated with AMT, JIT and TQM had improved manufacturing performance. An operator at Du Pont remarked:

“We do a lot of training...this year alone I've attended 4 different courses - customer specifications, process management, problem solving and decision analysis. We attend as a team and take 3 problems to each program which we develop together. 6 weeks later there's a one day review. Organising the training so that everyone in the team attends and real problems are solved makes these experiences really valuable.”

Second, consider the major changes to employee performance associations. In a weak benchmarking environment AMT, JIT and TQM, collectively explain 13.8% of the variance in manufacturing performance whereas in a strong benchmarking environment they explain 31.0% of the variance. In a weak ability to change environment AMT, JIT and TQM, collectively explain 36.5% of the variance in manufacturing performance whereas in a strong ability to change environment they explain 25.3% of the variance.
The impact of benchmarking environment on the associations between AMT, JIT and TQM and employee performance was discussed earlier. The positive effect of ability to change environment on the strength of the association between AMT (correlation co-efficient increases from -0.011 to 0.131**) and employee performance was supported by the case studies. Consider Kellogg, South Pacific Tyres, Australian Newsprint Mills and Pampas. In the early stages of these firm's capital expenditure programs, all were unable gain the commitment of their workforce to the introduction of new technology. The established site cultures strongly opposed change and as a consequence, compromise changes to organisational arrangements were adopted which severely limited the employee and manufacturing benefits obtained from the new technology. However, as other change activities were undertaken this resistance gradually reduced. Employees began to understand the rationale for change and in particular, view technological change more as an essential part of doing business and less as a threat. Consultative forums were applied at each site to redesign organisational structures and work processes with a view to supporting the vastly improved, data driven manufacturing processes. These new work environments provided employees with the opportunity and motivation to learn multiple skills and techniques which could be used to identify problems early in the production process. Moreover, the acquisition of a diverse range of new skills, abilities and insights by employees increased their scope of responsibilities and job satisfaction, increased pay and career progression opportunities and increased employee marketability. Consequently as the organisation development an ability to change, AMT had an increasingly positive effect on employee performance.

The negative effect of ability to change environment on the strength of the association between JIT (correlation co-efficient decreases from 0.311** to 0.127**) and TQM (correlation co-efficient decreases from 0.557** to 0.460**) and employee performance is also consistent with the finding that the strength of the associations between JIT and TQM and employee performance decrease as employee performance increases. It should be noted that the mean value of employee performance increases substantially with strength of ability to change environment, from - 0.147 (weak environment) to 0.266 (strong environment). Put differently, firms that can implement change easily are associated with substantially higher levels of employee performance and lower associations between JIT and employee performance and TQM and employee performance. There was also some evidence in the case studies to support this finding. Those firms that were further progressed toward best practice had substantially overcome organisational resistance to change. These firms tended to have institutionalised TQM and JIT "improvement planks" in place and were focusing change effort in other areas such as leadership, HR policy and teams. Consequently, it can be argued that the greater the firm's ability to implement change, the more developed the organisational environment and the
smaller the association between JIT and TQM and employee performance. Some firms (eg. Du Pont and Kellogg) also indicated the value of TQM in the initial stages of their change processes in breaking down barriers to change by increasing employee understanding of changing customer preferences and the actions of other competitors.

The Impact of Performance Environment on IM Facet and Practice Association (aggregated)

To obtain a general indicator of the collective level of association between IM facets and practices, the correlations between aggregated IM and practice constructs were evaluated. As hypothesised, the highest level of association (0.73) was found in the environment with weak employee/strong manufacturing performance (3.7% of the population) This environment also had the lowest mean value of leadership, training and benchmarking. The lowest level of association (0.41) between the aggregated IM and practice constructs was found in the environment with strong employee/weak manufacturing performance (4.1% of the population). This environment also had the highest mean value of teams and benchmarking. As there were 9 categories considered, the average number of firms in each category was 11.1%. The relatively small numbers of firms in these two categories, weak manufacturing/high employee performance and weak employee/high manufacturing performance is consistent with the high level of association between employee and manufacturing performance.

The case studies provided pockets of evidence to support the impact of the environment of strong employee/weak manufacturing performance on collective IM facet and practice association. Consider Australian Newsprint Mills and Edgell Bird’s Eye. Representatives of both firms indicated that employee performance was relatively strong. Climate surveys conducted 1 to 3 months prior to the case studies also confirmed these views. However, when operations were benchmarked against international operations, manufacturing performance was found to be in the lowest quartile in both cases. In both firms there was clear evidence to support loose coupling between IM facets and practices. First, the relationship between change process and strategy was unclear (refer also Chapter 5, Section 5.3.2). In particular, both firms were committed to the ideals of Best Practice and TQM and had strong strategic management processes but the linkages between strategic imperatives and organisational improvement had been poorly articulated. There were no processes or forums to link manufacturing strategies to change strategies. A manager at Edgell Bird’s Eye remarked:

"This business is seasonal. Right now we’ve got a record harvest and for the next 3 months we need the plant running 24 hours per day, 7 days per week. We need everybody working on production making sure that equipment is kept running, yields are maximised, quality is maintained and costs are kept down... all other projects have to fit in with this priority. There are no slack resources for long term development activity which bears some obtuse relationship to business performance."
The change champion at Australian Newsprint Mills also remarked:

“You’ve got to believe in these things. We’ve seen the impact of a committed and empowered workforce on production performance in American plants and have made that our number one priority. We believe that if we can achieve this and put the right systems in place, improvements in machine efficiency and unit costs will occur.”

As a consequence change activity was decentralised and to some extent, individually championed. For example, At Edgell Bird’s Eye the Process Technology Manager was responsible for AMT, the Customer Service Manager for TQM and the Operational Superintendent for JIT. These employees were all located in different areas and all remarked on the need for better co-ordination of change activity. Second, both firm’s change processes made heavy use of consultants who prescribed interventions without adequate assessment of their relationship to other change activities occurring at the site. As remarked by the change champion at Edgell Bird’s Eye:

“We should have done some form of site assessment before we started...as we didn’t do this we added additional complexity to an already complex change process. For example, we were half way through introducing TQM when we started a team development process. There were perceived and real overlaps between the two which caused confusion, wasted resources and fuelled cynicism.”

There was also evidence to support that these environments emphasised benchmarking and teams. Although all 12 firms introduced benchmarking and 11 firms introduced teams, the change processes of these two particular sites placed particular emphasis on these interventions. The change champion at Australian Newsprint Mills remarked:

“Our change process is based on benchmarking and teams. We use benchmarking to direct improvement and teams to implement improvement. Benchmarking gives us vital information to manage business performance and review business direction. Teams also benchmark to gather ideas for improvement and identify where we need to improve.”

None of the 12 firms studied reported strong manufacturing and weak employee performance and therefore it was not possible to develop insights into these firm types. Two general comments however can be made. First, the basis of competitive advantage in these firms is clearly derived from sources other than human resources. These sources could include: protected or regulated markets, patented product or process technology, access to financial resources and economies of scale (Pfeffer, 1994). It is hypothesised that a key future issue for
these firms will be the sustainability of performance (Stalk and Hout, 1990A, Stalk, Evans and Schulman, 1992). Not only is there an expectation that these sources of competitive advantage will erode (Challis and Samson, 1995B) but also a possibility that these firms will be ill equipped to change in response to changes in market delineations, competitor actions, customer preferences and in some instances, the basis of competition. These firms may risk “structural system dominance” (Challis and Samson, 1996B), that is, the possession of an insular company mindset which turns into a liability of inertia when the external environment changes. Past examples of firms with “structural system dominance”, are IBM, DEC, Westinghouse, GM, Kodak and Ford, all of whom became atrophied by their own internal inertia when the key changes occurred within the business and operating environment. Second, firms exhibiting “structural system dominance” generally excel at optimising static fit between business and organisational elements, for example, strategy, systems, structure and skills (Challis and Samson, 1996B). It can be hypothesised that the technologies used by these firms to optimise static fit can also be applied to optimise the fit between IM facets and practices. In sum, it is expected that firms with weak employee/strong manufacturing performance will have a greater disposition toward “structural system dominance” and as a consequence, obtain the higher levels of fit between IM and practice investments observed in the quantitative analysis.

6.3 Discussion: Qualitative Analysis

6.3.1 General Observations - Implementation of Change Activities

The case studies provided an opportunity to obtain rich insights into the change processes of 12 manufacturing firms. These studies considered the change drivers, change environments, change strategies, change activities and in addition, the outcomes achieved and the barriers encountered. The detailed descriptions of the change activities of three firms, suitably enriched with input from the other cases, provided a comprehensive account of what happened, when it happened, why it happened, who was involved and how they were involved. These were described in considerable detail in Chapter 5 and will not be repeated here.

The concept of Best Practice implies, by definition, that there are a set of practices that are best and that firms implementing these practices can expect to achieve significant improvements in both performance and competitiveness. Some leading organisations and researchers in the field of Best Practice take this further. For example:

“...Best Practice... can be expected to lead to world class outcomes in quality, and customer service, flexibility, timeliness, innovation, cost and competitiveness.”

Australian Centre For Best Practice (1994), pp 1.

The qualitative research performed as part of this dissertation clearly provides support
for the general proposition that appropriate combinations of technological, organisational and human resource investments do lead to improvements in performance and competitiveness (refer sections 6.2.2 and 6.2.4). Synergistic effects between these investments have also been observed in a number of different areas (refer Section 5.5, pp. 88). The interdependent nature of these investments discussed in the quantitative analysis (refer to Section 6.2.3) is also supported by the results of the qualitative analysis. IM facets and practices were observed to occur in various combinations. Nine of the twelve firms studied implemented 6 or more of the 10 investments considered. The smallest number of investments developed by any firm was four. This was found at Murray Goulburn. Interestingly, of the 12 firms studied, this firm reported the smallest gains from the change process. Alternatively Kellogg (10), Du Pont (9) and Pacific Dunlop Bedding (9) made significant investments and all reported substantial improvements in performance and competitiveness as a consequence of the change process. However, care need be taken in relating the number of investments to improved competitiveness or performance. First, there are exceptions. Edgell Bird’s Eye introduced more investments than Fibremakers but reported improvements in less areas. Second, response bias is a concern as the managers reporting the benefits of change processes were generally heavily involved in the actual change process and reporting poor outcomes might have pejorative connotations. It is noteworthy, however, that qualitative data was, in general, supplied from two managers within each firm and responses demonstrated a high degree of consistency. Snell and Dean (1991), and Balan (1995), obtained performance data from three different sources involving both managerial and non-managerial sources. In both instances high interrater reliabilities were obtained adding support and therefore the effects of bias are expected to be small (refer also Chapter 3 Section 3.3.4.3.2). Third, quantitative responses only identified categories of improvement and did not quantify the extent of improvement within a given performance category. Fourth, with the exception of expenditure levels, firms have not quantified the levels of investment made. Considerable variation in resource allocation was observed in the qualitative analyses. For example, all firms report investments in TQM. However, South Pacific Tyres have invested considerably more resources in more quality practices than firms such as Exicom and Murray Goulburn.

The firms studied used different combinations of investments and applied them in different sequences. There was no evidence to support the existence of a prescriptive Best Practice recipe. Moreover, those firms applying a prescriptive methodology (eg. Pampas and Edgell Bird’s Eye) encountered significant difficulties during the change process and as a consequence, major revisions were undertaken.

There was considerable evidence, however, to suggest that firms introduce different combinations of interventions in response to firm specific idiosyncratic characteristics and
needs, in particular change drivers and characteristics of the change environment. Don’s change effort was driven by the need to reorient operations from production driven to customer driven and consequently TQM formed the backbone of their change process. After the Pacific Dunlop acquisition, supplier rationalisation and reduction in materials costs became key objectives of the Edgell Bird’s Eye change process. Subsequent change activities placed heavy emphasis on JIT. Smorgon’s site exhibited traditional employer/employee relations tensions: low levels of trust and co-operation, extensive demarcations and restrictive work practices and frequent disputes. The change process at this site focused on workplace culture change through involvement, empowerment and collaboration and placed considerable emphasis on industrial relations reforms, the development of collaborative forums and processes (e.g. Consultative Committees) and effective, open, two way communication.

6.3.2 IM Facet and Practice Investments and Improved Competitiveness

A key lens of enquiry when conducting case studies was the development of relationships between IM facet and practice investments and improved competitiveness, or more generally, the organisational change process and competitiveness. Significant differences were noted in many firm’s approaches in this area. Moreover, considerable variation was often noted in the approaches of individuals within a particular firm charged with the responsibility of implementing a particular intervention. Individual’s responses may broadly be categorised into 5 main areas:

- emphasis on the form and structure of investments (Hayes and Pisano, 1994). Assessing the value of investments in terms of outcomes that relate specifically to those investments, eg. the number of plants to gain Quality Accreditation, the number of employees to receive TQM training and the number of AMT projects completed within budget and to schedule.
- emphasis on a generic organisational characteristics, for example, shared vision, shared values, acceptance of change, distributed leadership etc (refer Table 5.10). Investments were evaluated in respect to their impact on the development of these characteristics.
- emphasis on a few key organisational characteristics for example, acceptance of change and collaborative employee/employer relationships. Characteristic emphasis changes with progression of the change process. Investments were evaluated in respect to their impact on the development of these characteristics.
- emphasis on the value of investments in producing short term improvements in performance, for example, reduced labour strength and increased labour productivity.
- emphasis on the core set of order winning capabilities that energise a given firm’s strategy set. Investments and activities were evaluated in respect to their impact on the development of capabilities.
The last area provides the greatest opportunity for learning. As Hayes and Pisano (1994) have noted:

"companies that are able to transform their manufacturing organisations into sources of competitive advantage are those that can harness various improvement programs to the broader goal of selecting and developing unique operating capabilities."

The case studies indicated that capabilities may be realised through a number of different mechanisms, some of which involve investments in technology, organisations and human resources and some of which do not. Further, different firms focused on different IM facet and practice investments dependent not only upon capability requirements but also, the forces for change, the change environment and other site specific factors. Consider the following examples.

First, Fibremakers. Fibremakers' management turned a crisis into an opportunity: to survive and secure their future by introducing new manufacturing approaches and methods. Fibremaker's did not need to invest significant resources in overcoming resistance to change as closures and large scale retrenchments were commonplace within the textile industry. The retrenchment of the management team on acquisition, also demonstrated to all employees Du Pont's preparedness to make significant change and make it quickly. Fibremakers' teamwork capability also developed "naturally" through employees' will to contribute to the firm's survival rather than through a structured team development processes. The employee/employer relationship improved dramatically but not, for the most part, through the actions of Consultative Committees, the development of Collective Agreements or organisational restructuring. Rather, the threat of closure created a common purpose, and bond between management and the workforce which fostered understanding and cooperation. Interventions were also not introduced with the explicit goal of fostering workforce empowerment. Organisational delayering occurred to improve responsiveness, communications and reduce costs and as a byproduct, individuals responsibilities were greatly enhanced.

Fibremakers' success was largely attributable to its ability to develop an organisational wide continuous improvement capability whilst introducing transformational change. As remarked by the CEO:

"We needed people to believe in what we were doing and to want to work here...but we also needed them to accept that whatever we did, success in the longer term required their full commitment and involvement in the change process."

Fibremakers' change process sought to develop four key and interrelated capabilities. These were the ability to: 319
• achieve step change reduction in operating costs and simultaneously improve employee morale,
• develop employee understanding of the linkages between business performance and operational performance
• introduce and diffuse the Du Pont safety culture into other areas of business performance,
• harness the skills and abilities of the workforce to deliver a stream of improvements that reduced operating costs and improved product quality

As a consequence change activities were focused on a few key areas. Comprehensive communication and information sharing strategies were introduced to develop employee awareness of the need for significant change and to develop employee business awareness. Benchmarking was used to identify the magnitude of performance gaps (Best Practice to existing, break even to existing) and to identify key activities and processes for improvement. The need for change was therefore clearly expressed in terms of customer demands and competitor offerings and not in terms of arbitrarily defined management targets. Employee business awareness was progressed through developing understanding of benchmarking information and understanding of the relationship between changes introduced and reduction in performance gaps. The Supply Chain Management process was introduced to develop an organisational wide continuous improvement capability, more particularly, to ensure that the improvements introduced by an empowered and committed workforce produced tangible improvements in business and organisational performance. Key areas of functionality included: the capture and development of workforce suggestions for improvement, managing the implementation and co-ordination of improvement activity and evaluating the effectiveness of the actions taken. This process also helped to support the company’s endeavours to increase employee business awareness. Du Pont secondees with intimate knowledge of that company’s safety management processes were appointed to transfer this technology to the Fibremakers’ site and introduce an operating philosophy that reinforced the principles of the Supply Chain Management process.

Second, Kellogg. Kellogg identified five key capabilities that underpinned its future success. These were:
• shared strategic intent: all employees understand and commit to the firm’s future direction,
• the ability to use AMT to leverage changes in workforce culture,
• the development of collaborative relationships with the workforce
• supplier partnering agreements,
• teamwork.

As remarked by the change champion:
"...employees needed to understand the plan to want to contribute to its success so we spent a lot of time involving people in the strategic planning process. We'd seen the value of empowered workteams in some of our US operations where quality, productivity and flexibility had improved dramatically. These were all critical areas where we needed to improve to become successful in Asia and so it made a lot of sense to us to pursue teams...we also knew that the quality of the cereals and grains supplied to us would need to be improved considerably to sell in the Asian marketplace."

Kellogg sought to pursue these capabilities through a number of different initiatives. The introduction of English literacy training and application of the communication strategy "face to face to influence/media to inform," greatly improved communication effectiveness. Presentations, newsletters and various forums were used to discuss and debate the company's future direction and through this process a shared common direction emerged. Kellogg also used new technology as a vehicle to bring the company's strategic plan to life. The introduction of $1B of technology had a substantial impact on the work environment and the jobs of most employees. By using technology to introduce best practices, Kellogg was able to influence the attitudes and values of its workforce and develop a more collaborative site work ethic. This process was supported by a separate suite of initiatives that focused on the development of an egalitarian work environment. Initiatives introduced included enterprise agreements, the abolition of paid overtime and status symbols and innovative HR systems for the progression, development and remuneration of individuals and teams. Kellogg also facilitated the development of a number of networks and taskforces to pursue win-win solutions to different problems and issues. For example, by working with seed breeders, growers, millers and government agencies, Kellogg developed a new corn seed hybrid. This new seed reduced grain size variability and therefore improved product quality and in addition, increased grower's yields by 31%, miller's yield's by 26% and cooking yield's by 15%, resulting in a net yield increase of 90%. Through taskforce activities of this type, the various groups involved along Kellogg's value chain have developed a better understanding of each other's needs which in turn has catalysed further improvement projects and fostered the development of relationships based on trust and mutual dependence.

Third, Du Pont. Du Pont had been involved in the implementation of Best Practice concepts since the mid 1980's and as a consequence the culture change process within their manufacturing operations was well advanced. Du Pont management indicated that they believed the workforce were, for the most part, committed to the firm's vision, embraced the espoused operating values and accepted the concept of continuous change. Du Pont's core capability set was defined as:

- the development of a "volunteer" mentality to progress continuous improvement,
• the development of leadership at all organisational levels,
• developing employee's ability to champion Best Practices within other organisations

Du Pont believe that, in their work environment, continuous improvement is underpinned by a "volunteer" mentality: a preparedness by individuals to want to contribute of their own initiative. For this to occur a collaborative mindset needs to be developed between management and the workforce and the work environment needs to support concepts of empowerment, flexibility and teamwork. Du Pont also believe that this is not a sufficient condition for success. Rather, sustainable change requires employees to want to change their own behaviour and this cannot be externally induced. As remarked by the change champion:

"We spent a lot of time in the early days trying to put the right systems, structures and procedures in place and develop the right management style to create an environment that would lead to culture change...we found however that giving people the opportunity to change their behaviour and actually changing their behaviour are two different things... manager's can't change employee behaviour only the employee can do that."

Du Pont therefore buttressed their efforts to develop a “volunteer” mentality (eg. suggestion schemes, participation in change activities, problem solving teams, task forces etc) with a leadership development and organisational learning process. This process involved groups of employees participating in team based, experiential learning exercises. Outcomes from this process included practical solutions to existing problems, the development of team and individual learning capabilities and the nurturing of an environment of continuous improvement through leadership at all organisational levels. Du Pont's manufacturing operation has also found that its ability to further progress its competitiveness is constrained by the practices of a number of the organisations with which it interfaces. These organisations are both within and external to Du Pont. As a consequence, the operation is using "volunteers" to champion the diffusion of a select number of practices and characteristics within a range of organisations including suppliers, vendors, contractors, customers and the Du Pont divisions of finance and corporate planning. Not only has this activity increased the performance of these organisations and employee understanding of the role of manufacturing within the company's value chain, but it has also identified further opportunities for improvement within Du Pont and furthered the development of employee leadership capabilities'.

These three examples illustrate how some firms have pursued change processes with the primary objective of developing a unique and sustainable set of human resource based capabilities that drive future competitiveness. Although practice and IM facet investments did result in a number of short term improvements in manufacturing performance this was clearly
not the main reason for their introduction in these instances.

6.4 Chapter Summary

This chapter has provided a discussion of the findings from the quantitative and qualitative analyses. Qualitative analyses generally supported quantitative analyses although some areas of qualification were noted. Specifically, the 12 firms studied tended to emphasise linkages between IM facet and practice investments and improved performance and competitiveness due to the processes associated with the awarding and implementation of Best Practice grants.

The results of the quantitative research indicated moderate levels of association between employee and manufacturing performance with the qualitative and other prior research suggesting that improved employee performance leads to improved manufacturing performance. TQM and JIT were both found to have weak to moderate levels of positive association with both employee and manufacturing performance with AMT demonstrating small, if any association with performance constructs. AMT was, however, found to be positively associated with manufacturing performance but only in a strong TQM environment supporting the view that technology increases, rather than decreases, the need for a skilled and committed workforce. This finding was also consistent with other work that found TQM environments exhibit many characteristics (eg effective strategic planning processes, a preparedness to invest in human resources and an ability to implement change) that increase the probability that AMT investments will be successful. Strong AMT environments were also found to have weaker manufacturing performance than weak AMT environments if the levels of JIT and TQM investment were weak. However the associations between JIT, TQM and practices and employee and manufacturing performance were stronger in a strong AMT environment. The qualitative research supported these findings as AMT investments were found to effect most if not all areas of the organisation and have the potential to create a single focus and common platform from which to introduce other organisational and human resource investments.

The results of the quantitative research also showed TQM to explain twice the variance between groups with low/medium levels of performance than between groups with medium/high levels of performance. This observation was found for the dependent variables of employee performance and manufacturing performance. The qualitative research provided some support for this finding as some firms remarked that TQM was increasingly becoming a qualifier, rather than differentiator, of business performance.

Weak to moderate levels of association were also found between most combinations of practices and IM facets supporting the view that these investments are interdependent and
therefore tend to appear in combination. Strongest associations were observed between TQM and planning, TQM and leadership and TQM and HR policies reflecting the degree to which quality management concepts are applied systematically. It was also noted that strategic context, leadership and supportive HR policies have also been noted by many other researchers as key ingredients for the successful implementation of TQM. The qualitative research also provided insights to support associations between TQM and planning and TQM and leadership in particular. In one firm TQM had been instrumental in redefining product specifications and developing new marketing, distribution and manufacturing strategies. After the effects of AMT, JIT and TQM have been considered these three practices were also found to be the three practices explaining the most additional variance in employee and manufacturing performance.

Firms with strong manufacturing and strong employee performance were also found to exhibit lower mean levels of benchmarking and teams than firms with weak manufacturing and strong employee performance. However the practices of benchmarking and teams were found to increase the strength of the associations between JIT and TQM and employee and manufacturing performance. The qualitative analysis also provided data to support value of teams and benchmarking in increasing the value of TQM.

The association between IM facets and practices (aggregated) was found to be strongest in environments with weak employee/strong manufacturing performance and weakest in environments with strong employee/weak manufacturing performance. The case studies provided pockets of information to support the impact of a strong employee/weak manufacturing environment on this association. Some sites with strong employee/weak manufacturing performance were found to have change process that were not effectively integrated with their manufacturing strategies and to lack mechanisms with which to co-ordinate aspects of their change activity.

Five different approaches to the management of IM facets and practices were defined from the 12 case studies conducted. Significant differences were noted in the management approaches used by firms with considerable variation often noted in individual's responses within a particular firm. Two of these five approaches, the extreme states, had been previously defined by Hayes and Pisano (1994). Firms whose management approach focuses on the linkages between organisational and human resource investments and order winning capabilities (the most developed of the 5 states) provide the greatest opportunities for learning. Case studies conducted indicated that capabilities may be realised through a number of different mechanisms, some of which involve investments in technology, organisations and human resources and some of which do not. Further, different firms were found to emphasise different IM facet and practice investments dependent not only upon capability requirements but also, the forces for change, the change environment and other site specific factors. These
general observations were illustrated by describing the capabilities management approach of three firms: Kellogg, Fibremakers and Du Pont.
CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

7.1 Introduction

Chapter 6 discussed the results of this study. The purpose of this final chapter is to summarise the work undertaken and examine its contribution to the field of soft and hard AMT research. The material in this chapter is organised in 5 sections. Section 7.2 summarises each of the six chapters within this dissertation to this point. Section 7.3 is concerned with the contribution of this study. The material in this section is organised into six key areas:

- Empirical Support For Conceptual Theories (Section 7.3.1)
- Research Methodology (Section 7.3.2)
- Measurement Scales (Section 7.3.3)
- Theory Development (Section 7.3.4)
- Management Insights. (Section 7.3.5)
- Limitations and Suggestions for Future Research (Section 7.3.6)

Section 7.4 provides some concluding remarks and Section 7.5 provides a summary of the contents of this chapter.

7.2 Research Overview

The material in this section provides a brief description of the content and findings of Chapters 1 to 6 of this dissertation. The first subsection discusses the key objectives of this dissertation. The second subsection is concerned with the literature review and the third subsection discusses aspects of the research methodology. The forth and fifth subsections are concerned with the results of the quantitative and qualitative analyses, respectively. The sixth and final subsection is concerned with interpreting the results of these analyses.

7.2.1 Proposition Set - Lens of Enquiry (Chapter 1)

In response to increasing competitive pressures and changing customer requirements, growing numbers of manufacturing firms are transforming to a new paradigm of excellence (Drucker 1990, Hayes, 1991). Many firms are introducing different management and manufacturing technologies to make this transition. The introduction of “hard” Advanced Manufacturing Technologies (AMT’s) such as Flexible Manufacturing Systems and Computer Aided Engineering, Total Quality Management (TQM) and Just In Time (JIT) are key elements of the approach taken by many firms. Mortimer (1985), defined the joint application of these
three technologies as Integrated Manufacturing (IM). In IM, technologies work in concert to change the way goods are produced and people are managed.

Clearly each facet of IM can effect the nature of work and demands placed on employees. It has been argued that IM increases the skills required of employees, the amount of discretion they must be accorded and the impact that they have on production (Helfgott 1988, Majchrzak, 1988, Wamecke, 1988). Consequently, as the potential contribution of employees in IM settings is greater than it is in the traditional plant, employers are attracted to making additional investments in employees (eg. technical skills, leadership and behaviour) and the organisational environment in which they work (eg. teams, Human Resource policies and benchmarking).

This dissertation is primarily concerned with evaluating aspects of the relationships between IM facets, organisational and human resource investments and employee and manufacturing performance. The propositions tested in this research are grouped in four main areas:

- employee performance and manufacturing performance,
- IM facets and performance (employee and manufacturing),
- IM facets and human resource and organisational investments,
- IM facets, human resource and organisational investments and performance.

This dissertation also seeks to 1) gather insights into how IM facets and human resource and organisational investments relate to improvements in performance and competitiveness and 2) develop understanding of how these relationships develop over time.

7.2.2 Literature Review (Chapter 2)

The literature stream concerned with IM facets and human resource and organisational investments, is, in its most broadest sense, defined as AMT. Different researchers have ascribed differing definitions to AMT. There is no universally accepted definition for AMT nor is there general agreement amongst researchers of the key elements that should constitute such a definition. In this dissertation AMT was defined as:

‘the integrated system of technologies, practices, methods and techniques applied to the total value chain to develop order winning capabilities and/or achieve certain manufacturing goals.’

We provided a detailed discussion of the literature pertaining to AMT’s, including their use within industry. This discussion was organised according to a taxonomy of six attributes which were:

- the elements of AMT (hard and soft technologies),
- the integration of hard and soft AMT elements,
Many researchers were shown to have argued the need for hard AMT to be accompanied with substantial adjustments to organisational and human resource systems. The discussion of human resource aspects was then taken further through consideration of the literature stream concerned with human resource theories of competitive advantage. Essentially, this literature stream posits that not only are human resource and organisational investments required as a concomitant to the introduction of AMT to create the conditions necessary for success but that these investments can create a source of competitive advantage in their own right. The relationships between AMT and strategy were also considered. By presenting the arguments of various researchers it was shown that the appropriate combination of AMT's and strategy can change both the nature of the competitive environment and the ability of firms to compete. In particular, it was shown that hard AMT challenges the “focused factory” concept and supports the cumulative model of competitive capabilities.

The rich literature streams associated with three key soft areas of AMT were also discussed: TQM, JIT and organisational and human resource development. Analysis of this literature indicated that although there were many theoretical models and prescriptions for success, there is a dearth of rigorous empirical work with which to support them. The context in which AMT investments exist was also considered through examination of three paradigms commonly used to transform manufacturing: World Class Manufacturing, Best Practice and Integrated Manufacturing.

A number of shortcomings became apparent from this review. The bulk of the research on AMT's, both hard and soft, is either of a conceptual nature or is empirical work based on relatively small sample case studies. As a result theoretical frameworks for AMT are largely untested and what results have been obtained lack generalisability. Also, much of the research undertaken in the soft AMT areas is concentrated on assessing the “value” (it is accepted that causality can be implied but not proven) of a specific intervention, for example, TQM, remuneration, recruitment and employee empowerment. A focus on individual investments however, presents both theoretical and methodological dilemmas. Dow, Samson and Ford (1996), found the correlations between 8 HRM practice constructs to be all positive and statistically significant supporting the view that HRM practices are usually found in combination. Therefore, to the extent that the presence of any single practice reflects a firm's wider propensity to invest in other practices, estimates of the impact of a particular practice on
firm performance will be upwardly biased. This degree of interdependency between investments implies that the unit of analysis for assessing the impact of practices on performance, needs to be a “bundle” of investments rather than a particular investment although relatively little work has been performed in this area. A further limitation is associated with the constructs used to evaluate the “value” of AMT investments. For example, most empirical work concerned with “value” of soft AMT evaluates their association with constructs that measure productivity, motivation, morale, retention of quality employees and resignation of nonperformers (Jones and Wright, 1992, U.S. Department of Labour, 1993). A finding that a particular investment or practice is related to turnover or productivity does not necessarily mean that particular practice has any effect on manufacturing performance measured in terms of profitability, unit cost or customer satisfaction.

7.2.3 Methodological Considerations (Chapter 3)

The primary challenge in empirical research is the collection of data which will enable a priori proposition or hypothesis to be tested in a valid and reliable manner. In respect to the quantitative analyses component of this research, three aspects of validity were of concern: construct validity, convergent validity and discriminant validity. Considerable care was taken choosing and grouping questions into sets to measure the 12 constructs (AMT, JIT, TQM, ability to change, benchmarking, HR policy, leadership, planning, teams, training, employee performance and manufacturing performance) used. This process made extensive use of prior research and scales used in these areas (e.g. Snell and Dean, 1991, American Society for Quality Control, 1993, Balan, 1995, Dow Samson and Ford, 1996). Convergent and discriminant validity were checked using factor analysis (Bohstedt, 1983, Campbell and Fiske, 1959). All of the scales used in this research were also tested for reliability (Cronbach’s Coefficient Alpha). The final scales were shown to meet generally accepted criteria (Child, 1970, Tabachnick and Fidell, 1990) for validity and reliability.

In addition to the difficulty of gathering valid and reliable data, another obstacle confronting empirical researchers has been the difficulty of acquiring a truly representative data sample of sufficient size. Typical response rates for surveys in operation's management are between 15% and 35% (DeMeyer, 1987, Flynn, Sakakibara, Schroeder, Bates and Flynn, 1990, Vickery, Droge and Markland, 1993). The problem with these low response rates is twofold: (1) it is difficult to obtain a final population of sufficient size if less than one-forth of the companies contacted respond, and (2) there are serious concerns over the issues of response bias (i.e. is there a systematic difference between firms which do, and do not, respond?). Neither of these two issues was a particular concern in this study. Although the average response rate was only 33.5%, a total of 1289 responses was received. Response bias was assessed by asking 108
non respondents a sub-set of questions with high predictive validity. No significant bias was detected. Chi squared tests were also conducted on the final sample (1024 firms) to check for bias between retained and deleted data sets. Again, no significant bias was detected. A number of data checks were also performed in this analysis. Outliers, normality (skew and kurtosis), multicollinearity, and interval level checks were discussed as well as the assumptions that accompany the use of the various statistical techniques used. For example, multiple regression checks included: homoscedasticity, additivity, linearity, measurement error, normality of the variate, independence of residuals and recursion. General support was found for all checks and assumptions with any exceptions noted. A number of limitations and weaknesses were also discussed. It was noted that some constructs, in particular AMT, measured a hybrid of strength and perception of value. Also data was obtained from one site manager only and therefore interrater reliability assessments could not be undertaken to assess respondent reliability. Delays between the introduction of various human resource and organisational investments and improvements in manufacturing performance (Denison, 1982) may also affect results as the analysis only controlled for the effects of delays at the change process level.

Case studies of 12 manufacturing firms were also undertaken as part of this research. The data gathering process used was particularly comprehensive in enabling rich insights to be obtained due to the broad lens of enquiry applied and the large number of employees interviewed at each site. Many sources of secondary data (reports, change strategies, change reviews, presentation material etc) were available at each of the sites studied. Open access to personnel and information was also facilitated by each firm’s commercial obligation to partake in case studies as a condition for acceptance of the Best Practice grant. However, there were a number of limitations associated with this particular area of research. These included:

- response bias [the behaviour of firms that are recipients of Best Practice grants may be considerably different to that of other firms],

- the timing of the studies [improvements in workplace culture lead improvements in manufacturing performance by 2 to 3 years, Denison, 1982],

- the impact of the change champion(s) [the relationship between organisational investments and performance may be effected by the personal attributes of the change champion(s)].

7.2.4 Quantitative Analysis (Chapter 4)

Summary statistics were provided for each variable used in this research to develop insights into the responses that form each construct. Firms were found to make considerable investments in all areas with the possible exception of AMT as responses to these questions
were generally somewhat lower than those of other questions ranging from 2.07 to 3.08 (on a
scale of 1 to 5) with the majority of responses less than 2.80. It was noted that as AMT
questions used a hybrid scale measuring extent of use and perception of value, it was not
possible to assess the degree to which, for instance, high responses reflected high levels of use
and high contributions or low levels of use and high contributions. However, many firms
provided zero responses indicating that AMT investments of the types assessed had not been
made. This finding was consistent with observations made in the case studies undertaken as
part of this research. These studies indicated that, with some notable exceptions, firms were
biased toward organisational and human resource (rather than mainstream\(^1\) technological)
investments.

Various statistical techniques including correlation analysis, multivariate regression
analysis, ANOVA, MANOVA and discriminant analysis were employed to evaluate the various
propositions developed in this research. The zero order correlations between employee
performance and manufacturing performance constructs were examined to assess the extent to
which firms employ human resource based approaches to improving performance and
competitiveness (it is accepted that causality can be implied but not proven). The three
Integrated Manufacturing (IM) facets, AMT, JIT and TQM are three key technologies used by
firms to pursue manufacturing excellence and hence their associations with manufacturing
performance were assessed using multiple regression analysis.\(^2\) As these three technologies
are also underpinned by human resource based theories of competitive advantage (Dean and
employee performance were also assessed using multiple regression analysis. MANOVA\(^3\) was
used to assess the significance of each IM facet on employee performance and manufacturing
performance.

The linkage between IM facets and human resource based theories of competitive
advantage would also suggest that firms investing in AMT, JIT and TQM are likely to make
additional investments in practices such as benchmarking, teams, planning, leadership, HR
policy etc. Put differently, IM facets and practices are interdependent and hence tend to
appear in combination. Correlation matrices were prepared to examine these associations. The
literature further suggests that these additional investments also improve both employee
performance and manufacturing performance. Practices were added as a separate step in the
regression equations for employee and manufacturing performance (where IM facets are the
independent variables) to test for these effects.

\(^1\) Refer to Chapter 4, Section 4.2.1 and Chapter 6, Table 6.2 for supporting data.
\(^2\) All regression equations used in this analysis controlled for the effects of company size, industry type
and net elapsed time since the commencement of the change process.
\(^3\) The use of MANOVA was supported by the high level of association between employee performance
and manufacturing performance.
Numerous other tests were performed to assess more specific propositions developed in this research. For example, discriminant analyses were performed to evaluate whether the associations between IM facets and practices and performance varied as a function of the level of performance. The results were used to assess whether IM facets and practices explain the same degree of variance in manufacturing performance between low/medium performance and medium/high performance categorisations and evaluate the effect of these performance categorisations on the strength of the loadings of particular IM facets and practices on the discriminating function. Chapter 4 provides details of all tests performed and lists the key findings obtained.

7.2.5 Qualitative Analysis (Chapter 5)

Analysis of the change processes of 12 firms showed that the rationale for change, and therefore the objectives of the change strategy, varied widely. Typical reasons for change included: improve quality, reduce cost, increase responsiveness and survival. Change environments also differed substantially across all firms. Consequently, different barriers to change needed to be addressed and overcome at the different sites and this also had a significant impact on the change plan developed. Key differences included the degree of past exposure to change, industry and market volatility, quality of the employee/employer relationship, workload, retrenchments, literacy and labour turnover.

Although the change drivers and change environments indicated large differences between firms, the strategic management processes used showed considerable similarity. Each firm studied used a planning processes consisting of three key stages. The first, or NOW stage, consisted of an initial review of operations using some form of analysis or diagnostic. The second, or WHERE stage, defined the future state, typically in the form of a business mission, business objectives (growth, profitability etc), philosophy statement, core competencies and functional strategies. The third, or HOW stage, sometimes defined as the change plan, consisted of the detailed set of objectives, action plans, interventions and measures used to achieve the future.

The actual change processes that occurred at each site were found to be very different. Significant variations were observed in terms of what interventions and practices were used, how interventions and practices were used and the sequence in which they were introduced, who was involved and why and how they were involved.

As expected, the list of quantitative outcomes obtained was long and varied being somewhat dependent upon the change drivers, change environment and type of technological, organisational and human resource investments made. Outcomes reported included increased technological competitiveness, increased processing capacity, improved customer focus, reduced
processing time, reduced materials costs, increased productivity, reduced labour and increased manufacturing costs. All firms implemented TQM and therefore, as expected, all sites indicated improvements in quality and workforce skills. Nine sites introduced AMT however only seven reported the outcome "leading edge of manufacturing technology". Five firms implemented JIT and outcomes were mixed as different firms introduced different JIT practices to address different operational needs.

In respect to qualitative outcomes, all firms indicated that the change process had a positive effect on internal relationships and all firms, except Smorgons, reported extensive use of teamwork. Also, although all firms had implemented TQM, two firms indicated that the qualitative outcome, increased customer focus, was not an outcome of the change process. Further, only a relatively small number of firms indicated that the change process had improved the alignment between employee and stated company values and increased employee's acceptance of change. These different results served to indicate how the change processes within different firms reflected different management perspectives. All firms indicated that organisational investments were made to improve long term competitiveness rather than deliver short term improvements in operational performance. However, different firms emphasised different organisational capabilities dependent upon their unique set of operating and business imperatives and the development stage of their change process.

The barriers to change encountered by firms were also discussed. Barriers differed dependent upon the stage of development of the change process (commencement, implementation and completion). Five principal barriers to change were observed in the firms studied. These were: lack of real pressure for change, lack of acceptance of the direction for change, ineffective or inappropriate change plans, an inability to implement change and an inability to develop work environments that sustain improvement.

7.2.6 Discussion (Chapter 6)

The results of qualitative analyses generally supported those obtained from the quantitative analyses although some areas of qualification were noted. Specifically, the 12 firms studied in the qualitative analysis tended to emphasise linkages between IM facet and practice investments and competitiveness, possibly due to the processes associated with the awarding and implementation of Best Practice grants.

The results of the quantitative research indicated moderate levels of association between employee and manufacturing performance. The qualitative research supported this finding and indicated that the principal direction of causality was: improved employee performance leads to improved manufacturing performance. The finding that AMT was positively associated with manufacturing performance but only in a strong TQM environment
supported the view that technology increases, rather than decreases, the need for a skilled and committed workforce. This finding was also consistent with other previous work (eg. Dean and Snell, 1991, Zammuto and O’Connor, 1992, Zairi, 1993, Balan, 1995) which reported that TQM environments exhibit many characteristics (eg. effective strategic planning processes, a preparedness to invest in human resources and an ability to implement change) that increase the probability that AMT investments will be successful. The associations between JIT, TQM and practices and employee and manufacturing performance were also found to be stronger in stronger AMT environments. The qualitative research supported these findings as AMT investments were found to effect most if not all areas of the organisation and have the potential to create a single focus and common platform from which to introduce other organisational and human resource investments.

The results of the quantitative research also showed TQM to explain approximately twice the variance between groups with low/medium levels of performance than between groups with medium/high levels of performance. This observation was found for the dependent variables of employee performance and manufacturing performance. The qualitative research provided some support for this finding as a number of better performing firms remarked that TQM was increasingly becoming a qualifier, rather than differentiator, of business performance.

Firms with strong manufacturing and strong employee performance were also found to exhibit lower mean levels of benchmarking and teams than firms with weak manufacturing and strong employee performance. However, the practices of benchmarking and teams were found to increase the strength of the associations between JIT and TQM and employee and manufacturing performance. The qualitative analysis also provided data to support value of teams and benchmarking in increasing the value of TQM. The association between IM facets and practices (aggregated) was found to be strongest in environments with weak employee/strong manufacturing performance and weakest in environments with strong employee/weak manufacturing performance. The case studies provided some pockets of evidence to support the impact of a strong employee/weak manufacturing environment on this association. Some sites with strong employee/weak manufacturing performance were found to have change process that were not effectively integrated with their manufacturing strategies and to lack mechanisms with which to co-ordinate aspects of their change activity.

Valuable insights into the change management practices of 12 firms, and in particular, the relationships between organisational and human resource investments and order winning capabilities were obtained in this research. Significant differences were noted in the change management approaches used by the different firms with considerable variation often noted in individual’s responses within a particular firm. Five different change management approaches were observed. Two of these five approaches, emphasising the form and structure of investments and emphasising the relationship of investments to order winning capabilities had
been previously defined by Hayes and Pisano (1994). Firms whose change management approach focused on the linkages between organisational and human resource investments and order winning capabilities provided the greatest opportunities for learning. Case studies performed in these firms indicated that capabilities may be realised through a number of different mechanisms, some of which involve investments in technology, organisations and human resources and some of which do not. Further, different firms were found to emphasise different IM facet and practice investments dependent not only upon capability requirements but also, the forces for change, the change environment and other site specific factors.

7.3 Research Contributions

7.3.1 Empirical Support For Conceptual Theories

This dissertation has gathered data to empirically test aspects of a number of different theories drawn from the literature on hard and soft AMT. These theories are both conceptual (the value of hard AMT in changing organisational culture [Zammuto and O'Connor, 1992], specialist/operator control work design theory [Wall Corbett, Martin, Clegg and Jackson, 1990] and workforce control/commitment strategies, [Walton, 1985]) and descriptive (TQM, World Class Manufacturing and Best Practice). Theories are primarily based on small sample case studies. This study provides an analysis based on a very large sample of firms which demonstrate substantial variation in terms of performance and soft and hard AMT use. Therefore, this sample provides a more generalisable test for a number of theories regarding AMT’s than would a small sample of the nature most often employed. Further, a detailed set of case studies were undertaken to address issues of causality and gain further insights into the relationship between technological, human resource and organisational investments and performance. The results provide empirical support for several theories.

- Human resource contributions have a significant effect on manufacturing performance. Case studies indicated that employees can affect manufacturing performance through their ability to adapt to particular environmental requirements. As these requirements varied substantially between firms, significant differences were observed in the way employee contributions were used. For example, developing a productivity advantage by identifying and introducing more efficient means for accomplishing tasks, developing a materials advantage by forming alliances with key suppliers, developing a strategic change capability by developing employee’s ability to understand, accept and implement change.
A full list of findings from the analyses is provided in Table 7.1.

7.3.2 Research Methodology

Empirical research in Operations Management (OM) has been criticised for deficiencies in rigour and generalisability. This dissertation used a survey instrument developed by a committee of leading academics (including the author's supervisor), site managers and the Chairman of The Australian Quality Awards Foundation. The committee used a number of sources in developing the instrument including the Malcolm Baldrige Awards Criteria, the Deming Prize Criteria, Ernst and Young American Competitiveness Study, Australian Best Practice Demonstration Program Criteria, Made In Britain and the AMC Emerging Exporters Study. Further the analysis performed in this dissertation used the responses obtained from 1024 manufacturing firms and therefore has high generalisability. Case studies conducted as part of this research also used a detailed 22 page case study protocol document supplied by the Department of Industrial Relations. Specifically, the following methods have been used in this research:
• **Scale development.** Wherever possible, the committee used questions and scales from existing instruments that were known to be reliable and valid. Where no such instrument existed, the committee developed scales in conjunction with managers and other practitioners. The final questionnaire was pilot tested with the manufacturing managers of 6 firms. Feedback and suggestions for improvement were analysed and the questionnaire was subsequently revised.

• **Response bias.** The Australian Manufacturing Council conducted a telephone survey of 108 non respondents. Non respondents were asked a sub-set of questions that had high predictive validity for the rest of the questionnaire. No significant response bias was detected (Australian Manufacturing Council, 1994A).

• **Respondent fatigue.** Given the length and complexity of the survey instrument checks were made for respondent fatigue. Ergas and Wright (1994), checked for respondent fatigue by applying two key tests. First, the associations between similar questions asked in different parts of the questionnaire were checked for consistency. Second, where the tone of a particular question differed from that of the surrounding questions, the correlation between responses was checked to see whether the respondent was alert to the changes in scale. The results of these tests indicated that respondent fatigue was not a significant concern.

• **Sample stratification.** Firms were selected from all industry sectors. For each country, the sample was stratified using twelve two digit industry codes (ASIC and NZIC) and three size categories ("small" 20 - 49 employees, "medium" 50 to 99 employees and "large", greater than 100 employees). Sampling frames were designed to ensure that all 36 cells had a minimum number of respondents. For example, in the Australian sample, each cell contained a minimum of 15 respondents.

• **Industry effects.** Checks were made for industry effects. Dess, Ireland and Hitt (1990), found that many studies in the field of operations management have problems with industry effects which tend to confound the results of the given studies. The effects of industry type were controlled for in all tests performed. However in no instance was this variable found to be statistically significant further enhancing our confidence in the generalisability of the results.

• **Company size.** The effects of company size were controlled for in all tests performed. Larger firms were found to be exhibit generally higher levels of practice use.

• **Duration of change process.** The effects of change process duration were controlled for in all tests performed. In no instance was this variable found to be statistically significant.
• Final sample representativeness. The final sample size used in the analysis in this dissertation was 1024 firms. The 265 deleted cells were tested for response bias by comparing them to the retained dataset using MANOVA. No significant difference was detected.

• Investment interactions. As noted in Section 7.2.2, organisational and human resource investments are interdependent and therefore should be analysed as a "bundle" otherwise estimates of the impact of a particular investment on firm performance will be upwardly biased. This research addresses this issue by using the site, rather than the investment, as the unit of analysis.

• Case study protocol. A detailed case study protocol was prepared and forwarded to each site prior to conducting interviews. This helped to ensure that interviewees were adequately prepared and a consistent data gathering approach was adopted.

7.3.3 Measurement and Scales

Many authors have argued the need for both a standardised terminology and reliable scales to empirically measure key issues in manufacturing strategy, operations management and technology strategy (Adam and Swamidass, 1989, Anderson, Cleveland and Schroeder, 1989, Merideth, Raturi, Amoako-Gyampah and Kaplin, 1989; and Flynn, Sakakibara, Schroeder, Bates and Flynn, 1990). These concerns were particularly germane to this research which invested considerable time highlighting the deficiencies in these areas. The survey instrument used in this research attempted to bridge theory and practice by making extensive use of measures and scales used widely by practitioners to measure constructs (eg. JIT, TQM and Strategic Planning) supported by extensive literature streams. The questions (and scales) used to measure IM facets in this work were similar to those used by Dean and Snell, 1990.

7.3.4 Theory Development

This study has made several contributions to the advancement of the state of theory developments in the area of technological, organisational and human resource management. First, deep empirically based insights were provided into the patterns of soft and hard AMT implementation, with particular emphasis on the interdependencies and synergies between the various investments made. Second, the results of hierarchical regression provided solid evidence to support the proposition that firms which invest in AMT must simultaneously invest in infrastructural improvements of the TQM type. Third, the results of hierarchical regression also supported the proposition that AMT creates an effective platform from which to implement
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<td>KEY FINDINGS : Quantitative Analysis (1/2)</td>
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- **Employee Performance and Manufacturing**
  Employee performance is positively related to manufacturing performance.

**IM Facets and Employee Performance and Manufacturing Performance**
- AMT, JIT and TQM are positively related to employee performance.
- JIT and TQM are positively related to manufacturing performance.
- Stronger associations between IM facets (AMT, JIT and TQM) and employee performance than IM facets and manufacturing performance

**AMT**
- AMT is positively related to manufacturing performance but only in a strong TQM environment.
- The interactive term AMT * TQM is positively related to both employee performance and manufacturing performance.
- Firms weak in AMT, JIT and TQM have stronger manufacturing performance than firms weak in JIT and TQM but strong in AMT.
- The greater the investment in AMT the weaker the association between employee and manufacturing performance.
- JIT, TQM and the seven practices explain more variance in both employee performance and manufacturing performance in stronger AMT environments.

**TQM**
- TQM explains more variance between groups with low/medium levels of manufacturing performance than between groups with medium/high levels of manufacturing performance.
- TQM explains more variance between groups with low/medium levels of employee performance than between groups with medium/high levels of employee performance.
- The strength of association between employee performance and manufacturing performance does not increase with strength of TQM environment.
### TABLE 7.1

**KEY FINDINGS: Quantitative Analysis (2/2)**

**IM Facets and Practices**
- A general weak to moderate and positive association between IM facets (AMT, JIT, TQM) and practices (ability to change, benchmarking, HR policy, leadership, planning, teams, training)

**IM Facets, Practices and Performance**
- The practices of planning, leadership and HR policy have moderate associations with employee performance and manufacturing performance
- The practices of benchmarking and teams have weak, if any, association with employee performance or manufacturing performance
- After the effects of AMT, JIT and TQM have been considered, practices account for additional variance in employee performance
- After the effects of AMT, JIT and TQM have been considered, practices account for additional variance in manufacturing performance
- Firms with strong manufacturing performance and strong employee performance do less benchmarking and have fewer teams than firms with weak manufacturing performance and strong employee performance.
- The practices of benchmarking and teams increase the strength of associations between JIT and employee performance and JIT and manufacturing performance
- The practices of benchmarking and teams increase the strength of associations between TQM and employee performance and TQM and manufacturing performance
- The practices of planning and training increase the strength of the associations between AMT, JIT, TQM and manufacturing performance
- The practices of benchmarking and ability to change increase the strength of associations between AMT, JIT, TQM and employee performance
- The association between practices and IM facets (aggregated) is strongest in firms with strong employee performance and weak manufacturing performance
- The association between practices and IM facets (aggregated) is weakest in firms with weak employee performance and strong manufacturing performance
### TABLE 7.1

**KEY FINDINGS: Qualitative Analysis (1/2)**

**Change Plan/Change Process**

- Firm's need to develop improved management technologies to identify and implement change activities. This was supported by a number of findings including: weak linkages between business requirements and change activities, overlapping change activities creating confusion and resourcing concerns, an inability to adhere to change plans, an inability to realise desired outcomes and reduced management confidence in change activities.
- Safety management processes can be effective management technologies to progress the development of workplace cultures.
- Significant interest and cautious optimism of the value of teams as a vehicle to progress workplace culture.
- Despite the significant investments made, many firms are experiencing considerable difficulty in obtaining employee buy in to change plans and activities.
- AMT can create a common platform from which to integrate other initiatives and change workplace culture.
- AMT investments need to be accompanied with an appropriate set of organisational and human resource investments.
- Consultative committees were a key instrument in management and implementation of change.
- Firms encounter different barriers to change at different stages in the change process.
### TABLE 7.1

**KEY FINDINGS: Qualitative Analysis (2/2)**

**Value of IM and Practice Investments**

- Although IM facets and practices create a work environment conducive to empowerment, they do not necessarily create an empowered workforce. In some firms entrenched cultural norms were such that few employees were prepared to change their mindset and behaviour. There was some evidence to suggest that in these environments interventions more directly affecting employee behaviour and motivation eg. organisational learning, remuneration, leadership, self awareness could be effective.
- Some firms continue to focus on the form and structure of IM facet and practice investments rather than their contribution to improved competitiveness.
- Firms gaining the greatest long term benefits from IM and practice investments appear to focus on the contribution of these investments to a specific set of order winning capabilities. Some firms were not able to manage capabilities effectively.
- There was general agreement amongst participating firms that employee performance will increasingly underpin their success.
- There was some evidence to support that firms’ change processes generally emphasise human resource and organisational (rather than technological) investments.
- Change champions had a significant impact on the outcomes achieved. It was extremely difficult to decouple the effects of the intervention from those of the individuals charged with its implementation.
- Some firms are gaining substantial improvements in competitiveness and productivity through full value chain integration (development of collaborative relationships with vendors, suppliers, customers, regulatory authorities etc).
- The pace of reform is very much slower than envisaged or desired. This is particularly evident on sites lacking real pressure for change. As a consequence, there is some evidence to support an increasing sense of urgency for significant change as competitiveness gaps are not closing quickly enough.
and effectively integrate JIT and TQM investments. Fourth, the results of discriminant analysis indicated that TQM's potential to effect improvement in employee and manufacturing performance reduces substantially as performance increases. Case studies performed also supported this finding with better performing firms indicating that TQM was increasingly becoming a qualifier for doing business rather than a discriminator of business performance. Finally, the evidence (qualitative and quantitative) indicated that of the 10 practices, investments and capabilities examined, the practices of HR policy and leadership are the strongest differentiators of performance amongst better performing firms.

7.3.5 Management Insights

This study provided a number of managerial insights for manufacturing executives either considering, or already involved with, soft and hard AMT investments. First, hard AMT investments need to be accompanied with organisational and human resource investments. Therefore managers should carefully consider investments in infrastructural improvements such as skills development, organisational restructuring, job design and employee empowerment. Second, the introduction of hard AMT can create a unique opportunity for organisational restructuring and facilitate the effective introduction of organisational and human resource investments. Third, TQM's effectiveness reduces at higher levels of performance and the interventions of HR policy and leadership become key differentiators of performance. Firms need to ensure that the practice investments made are consistent with their level of development and performance. Fourth, practices are highly interdependent and firms need to invest in a number of areas to realise improvements in performance and competitiveness. Fifth, to avoid “fad surfing” (Kaufmann, 1992) and resource crises, firms should carefully develop change strategies which clearly link the introduction of interventions to enhancements in the value of order winning capabilities and adhere to the change strategy developed unless a compelling business logic emerges to do otherwise. Sixth, the case studies provide substantial evidence to support the value of developing collaborative relationships with select groups of suppliers.

7.3.6 Limitations and Suggestions for Future Research

This research has provided a glimpse into the value of IM facet and practice investments and their patterns of implementation. There clearly remains a need for further empirical studies to examine many different aspects. Research strategies also need to consider a blend of quantitative techniques to identify key themes for enquiry and satisfy generalisability requirements and qualitative studies which serve to develop detailed insights into specific
investments and understanding of the complexities of change. Specific themes for future research include the following:

- **Studies that incorporate a broader range of commonly used management technologies.**

  This dissertation was concerned with "what works": that is, assessing the relationship between investments in IM facets and practices and improvements in performance. However, the lens of enquiry was restricted by the perspectives assessed in the dataset available and, as noted earlier, these may upwardly bias the "value" of a particular investment due to the high level of interdependency between investments. Future research should include investments in other frequently used management technologies such as process improvement, business process re-engineering, organisational learning, concurrent engineering, organisational redesign, work redesign, measurement technologies etc.

- **The development of standard measures.**

  One of the limitations of this research was that some constructs were evaluated using question sets that captured limited theoretical perspectives and that were not widely used elsewhere in the literature. For example, the team construct only evaluated the extent of use of various types of teams (eg. process improvement teams, cellular work teams, quality teams etc). It did not evaluate issues such as stage of development (Tuckman, 1965 and Osborne, Moran Musselwhite, Zenger and Perrin, 1990), organisational arrangements, group processes, role and goal clarity, task complexity and interdependency and team and individual empowerment all of which have been argued to impact on team performance and value (Erwin, 1995, Gladstein, 1984, Hackman, 1989, Kolodny and Kiggundu, 1980, Lawler, 1992, Sundstrom, DeMeuse and Futrell, 1990). Similarly, the leadership construct primarily reflected senior executive behaviour in leading the change process: eg. the ability to implement a culture of trust and commitment, the ability to create unity of purpose and the ability to champion "Best Practices". Limited, if any, insights were captured that reflect middle management or shop floor leadership capabilities which have been argued to be key to the development of a world class manufacturing capability (Richards, 1993, Samson, 1991). As noted by many OM researchers, the development of knowledge in this discipline has been retarded by the lack of standardised and widely accepted measurement sets. Ideally, measures satisfying acceptable standards of academic rigour and incorporating the appropriate set of theoretical perspectives need to be developed as a precursor to the widespread development and testing of AMT and Best Practice theories.
The relationship of TQM to improved performance and competitiveness.

Although this study clearly demonstrated the value of TQM in improving employee and manufacturing performance it also raised a number of key issues for further investigation. TQM’s value reduced at higher performance levels. Further work is needed to develop and confirm this preliminary finding. This research also indicated that different firms derived different benefits from TQM, for example: a shop floor continuous improvement capability, enhanced understanding of customer needs, better skilled workforce, improved process and product quality, less waste and rework etc. The development of a full taxonomy of TQM benefits would provide a starting point from which to develop further insights into TQM’s value within better and poorer performing firms. Once key areas of difference had been identified, the lens of enquiry could then shift to identifying business, organisational and operational attributes that determine these differences. A number of these attributes have been identified in this research in the form of barriers to change and classification of the change environment. These insights could be obtained from a suite of detailed, longitudinal case studies of organisational change processes using the change model described in Section 5.1.

Assessment of “hard” technological competitiveness.

The results of this research would suggest that many firms are not accompanying their investments in organisational and human resource areas with investments in hard AMT. This would suggest that the dominance of the Organisational/Human Resource reform agenda within Australian and New Zealand manufacturing firms during the last decade may have had a negative impact on some firm’s (international) technological competitiveness. Future research should consider whether a technological “competitiveness gap” does exist, and if so, quantify its magnitude and its impact on manufacturing performance and manufacturing competitiveness. Research in this area should also consider the extent to which the development of organisational and human resource systems is impeded by technological limitations.

Evaluate and contrast successful and unsuccessful AMT investments

Realistic assessments need to be made of IM facet and practice successes and failures and empirical evidence developed to distinguish between the two. There is currently a preponderance of case studies documenting the successful introduction different interventions. For example, consider the studies of hard AMT by Avishai (1990), Lei and Goldhar (1991), Merideth (1987A), Venkatesan (1990), Zairi (1993) and Balan (1995).
• Develop understanding of the connections between IM facet and practice investments and improved competitiveness and performance

Longitudinal case studies are required to not only address issues of delay and causality but also to gain deeper insights into how organisational and human resource investments translate into improvements in competitiveness and performance over time. These studies should also address issues of synchronicity (eg. AMT and TQM) and lead/lag (eg planning and AMT) between the various interventions and practices adopted by firms. Such insights would hopefully assist in the development of guidelines and principles to assist practicing managers.

• IM facet and Practice Investments and Business Strategy

This research has clearly demonstrated that employee performance has a substantial effect on manufacturing performance. Researchers and practitioners such as Barney (1986), Lawler (1992), Pfeffer (1992), Stalk (1991), and Stalk, Evans and Shulman (1992), have also argued that as traditional sources of competitive advantage continue to decline, interest in human resource based origins of competitive advantage, and therefore interest in organisational and human resource investments (Dean and Snell, 1991) will increase. This implies that organisational and human resource investments will have an increasingly important effect on business strategy and business performance and that employee and manufacturing performance constructs will migrate toward a common construct. Therefore, a key research theme is the nature and form of the relationships between organisational and human resource investments and business strategy and knowledge of how these relationships develop over time. These relationships should also consider the impact of the business environment. For example, it can be hypothesised that firms competing in relatively static business environments would apply investments to improve productivity and reduce costs along the total value chain whereas those firms competing in dynamic business environments would apply investments to increase their ability to sense the need for change (market acuity) and increase their ability to implement change.

7.4 Conclusion

Firms investing in IM facets and practices generally outperform firms which do not. Investments in the areas of leadership, HR policy, planning, TQM and ability to change have the greatest impact on performance. In addition, employee performance was shown to be a strong driver of manufacturing performance. The implications of these findings for managers is clear and the interest in this research by practitioners is heartening. Several participants in this
research have expressed an interest in participating in further research and discussing the results in respect to their existing situation.

It is encouraging that manufacturing managers are becoming increasingly committed to the need to introduce organisational and human resource investments in order to maximise the value of employee contributions to the business. However this research provided a number of salient notes of caution. Firms need to introduce these investments within a strategic context that provides a demonstrable link to competitive and performance requirements otherwise investments risk becoming “flavours of the month” rather than building blocks that contribute to the development of key organisational capabilities. This structure also helps to ensure that firms introduce interventions using a planned process, thereby avoiding resource crises and confusion created by an excessive number of fragmented interventions. Firms also need to ensure that technological and organisational investments are integrated effectively in order to achieve optimal advantage. Finally, a structured sequence of investments that supports the firms strategic intent is a necessary, but not sufficient, condition for success. Although investments may create a work environment conducive to culture change, existing cultural norms may be such that relatively few employees are prepared to change their mindset and behaviour. This dissertation provided some evidence to suggest that in these environments this resistance to change may be overcome by interventions and approaches that more directly affect employee behaviour such as: organisational learning, leadership, safety management, reward systems and self awareness.

7.5 Chapter Summary

This chapter presented the conclusions of this study. The chapter began by reviewing the rationale for the study and the objectives of the research. It was shown that the recency of developments and scarcity of empirical works in the field, when coupled with the mixed results obtained had left many questions concerning IM and practice investments unanswered. Through a detailed analysis of the literature, a number knowledge voids were identified which were then articulated in the form of a set of propositions. This research then focused on testing these propositions by analysing the practices and performance of 1024 Australian and New Zealand manufacturing firms and the experiences of 12 major Australian manufacturers involved in Best Practice activities.

A brief discussion of the methodology applied in this research was provided. The large cross sectional study was used to evaluate aspects of the relationships between IM facets, practices and performance with case studies used to address issues of causality and gather insights into how IM facets and practices relate to improved performance and competitiveness. A brief discussion was also provided of the quantitative methodologies employed in this study and the process used, and key results of, the qualitative analysis.
The contributions of this work were then discussed. The research was shown to provide empirical support for theories that relate to the business value of employee contributions, the value of IM facets in improving performance, the interdependent nature of IM and practice investments and the value of IM and practices investments in developing order winning capabilities. A number of strengths of the research methodology employed in the quantitative research were then discussed. These strengths included: sample size, checks for non respondent bias, checks for bias in incomplete responses, checks for respondent fatigue and analysis of a “bundle” of investments. The research was also shown to provide a number of practical managerial insights including: the need to ensure hard AMT is accompanied with investments in soft management technologies, the value of hard AMT as a unique occasion for organisational restructuring, the reduced effectiveness of TQM at higher performance levels and the value of developing collaborative relationships with a select group of suppliers.

This chapter also discussed a number of research limitations and suggestions for future study. Specific themes for future research included the addition of other management technologies as independent variables, refinement of the scales and measures used, assessment of the level of hard AMT competitiveness, examination and analysis of AMT failures and investigation of the relationship between investments in IM facets and practices and firm strategy.

To conclude, this study has examined a subject of considerable interest and importance to the survival and future competitiveness of today’s firm. In response to escalating competitive pressures, many firms are striving to develop the capabilities to simultaneously compete on many fronts (eg. cost, quality, responsiveness, flexibility and innovation) and consequently there is a pervasive “sense of urgency” to invest in technological, organisational and human resource areas. The results of this study clearly show that IM and practice investments do provide solutions to some of the key challenges facing firms and that employees play a key role in this change process.

Change is a complex and evolutionary process requiring significant investment, patience and perseverance. The plethora of interventions, tools and techniques and conflicting advice available to practitioners serves to further complicate the change process. The results of this research provide some key insights into “what works and why.” This research also indicates a need for further research in many areas in order to create a platform of knowledge that can be confidently applied to organisations to assist in the quest for world class standards of performance and competitiveness.
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376


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