

UNIVERSITY OF LANCASTER

MANAGEMENT SCHOOL

**A NEW WORLD CLASS MANUFACTURING MODEL FOR
SMALL AND MEDIUM SIZED MAKE-TO-ORDER COMPANIES**

By

Mohd Shaladdin Muda

B.Sc., MBA

Submitted for the degree of Doctor of Philosophy, April, 2001

ProQuest Number: 11003623

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 11003623

Published by ProQuest LLC (2018). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

**A NEW WORLD CLASS MANUFACTURING MODEL FOR SMALL AND
MEDIUM SIZED MAKE-TO-ORDER COMPANIES**

By

Mohd Shaladdin Muda

B.Sc., MBA

Submitted for the degree of Doctor of Philosophy, April, 2001

ABSTRACT

There have been many attempts to build comprehensive models for performance improvement, coming under a number of banners including Total Quality Management (TQM), Business Process Re-engineering (BPR) and World Class Manufacturing (WCM). Comprehensive models of this type are important because they bring together many aspects of Operations Management, and in so doing aid companies to not only identify, but also prioritise the improvements needed. However, although the diversity of the manufacturing sector is widely acknowledged, most of these models pay little attention to company type. Instead, generic, universalistic models are built, which are aimed at all manufacturing companies. This has tended to result in models that assume the manufacture of fairly standard products on a repeat basis, as is found in the more common Make-to-stock (MTS) sector of industry. Thus the models suggest that performance improvements will include a simplified shop floor cellular layout; a fairly constant customer base with easily identifiable product or customer families; a JIT style control of inventory; and so on.

Where the assumption regarding repeat production does not apply, large parts of the universalistic models can be irrelevant. This is true for the Make-to-order (MTO) sector that makes highly customised products in low volumes on receipt of customer orders. More importantly, the universalistic approach omits issues that are pertinent to MTO companies. These include the flexibility of process that often requires a job shop layout; methods to control workloads/queues in that environment; systems for determining the price and delivery to quote during the competitive bidding process in which most MTO firms are engaged; and effective means of producing designs for new products.

This thesis describes a research project which aims to fill this gap in the literature by developing a comprehensive WCM performance improvement model for the MTO SME sector. The new model, which has been named the “SHEN” model, is therefore contingent on company type. This thesis describes the research process followed to develop this model. This included deductive research whereby the initial model was developed using literature evidence and past experience of the authors, followed by inductive research in which case study data was collected from six MTO SMEs in order to develop the model further. The model aims to help companies determine which performance improvements are needed and how to prioritise them in the race to be world class. The case study research was exploratory in nature and aimed to gain further insights into the issues and solutions that are pertinent to MTO SMEs. The results suggested that some of our initial assumptions needed to be modified. For example, it was initially assumed that MTO companies should aim for a high level of worker flexibility, higher even than is achieved in the MTS sector, given the high variety of customised products. However, it was concluded that training is expensive

in this highly skilled sector and that it is often only necessary to have a few workers trained for particular processes. Therefore, a training needs matrix should be devised which establishes the number of people that need to be trained in each skill. Any further training is unnecessary and will soon be wasted as, without the experience of using the new skill, it is likely to be quickly forgotten. The case study evidence also suggested that the need for simple, movable equipment is less important because these companies often need specialised machinery and maintain a flexibility of process through a traditional functional layout. As well as being important aspects of the new model, conclusions of this type are important insights into best practice in MTO companies in their own right.

SEMINARS AND PUBLICATIONS

Part of this work has been accepted for publication:

“Developing a New World Class Model for Small and Medium Sized Make-To-Order Companies”, *International Journal of Production Economics*. (with L. C. Hendry).

In addition, the following conference papers have been presented/accepted:

“Proposing a World Class Concept for the Make-To-Order Sector”, Working Paper presented at the *British Academy Management (BAM) Annual Conference*, Manchester, England, Volume II, pp 1376-1377, 1-3 September 1999, ISBN No. 0 905304 27 6. (with L. C. Hendry).

“Applying World Class Principles for the non Make-To-Stock Sectors”, presented at the *Eleventh International Working Seminar on Production Economics*, Innsbruck, Austria, Volume III, pp. 361-385, 21-25 February 2000. (with L. C. Hendry).

“THE SHEN MODEL: to aid performance improvement in MTO SME’s”, accepted for presentation at the *International Annual Conference - European Operations Management Association, EurOMA 2001*, 3 to 5 June 2001. (with L. C. Hendry).

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deep gratitude to my supervisor, Dr Linda Caroline Hendry, for being very supportive and helpful throughout my studies. Her willingness to advise me at almost any time when she was extremely busy is very much appreciated.

I am also most grateful to my wife Radziah Ja'afar for her indispensable support during my course. Not forgetting my three lovely children, Farah, Burhan and Kushairi.

Lastly, I would like to thank Dr Brian Kingsman for his constructive comments and helpful suggestions during the early stages of writing this thesis.

TABLE OF CONTENTS

	PAGE
Chapter 1: Introduction	1
1.1. The need to aspire to be World Class.	1
1.2. The relevance of WCM research to the Make to Order sector.	4
1.2.1. The differences between Make to Stock (MTS) and Make to Order (MTO)	6
1.3. The diversity of the MTO sector	9
1.3.1. The difference between ATO and MTO/ETO	9
1.3.2. Amaro <i>et al.</i> 's (1999) taxonomy of MTO companies	12
1.3.3. Repeat Business Customisers (RBC) and Versatile Manufacturing Companies (VMC)	16
1.3.4. Small and Medium Sized Enterprises (SMEs) in the MTO sector	17
1.4. Research objectives and questions	17
1.5. Structure of this thesis	19
Chapter 2: Research Methodology	21
2.1. Management Research Perspective	21
2.2. Methodological Triangulation	25
2.2.1. Deductive VS Inductive	25
2.3. Case Study Research	28
2.4. Why Case Studies?	29
2.5. Data Sources	31
2.6. Conclusion	33
Chapter 3: A Literature Review of the World Class Manufacturing Concept	35
3.1. The Universalistic Approach	36

3.1.1. Superior Competitor	36
3.1.2. Customer Focus	37
3.1.3. Lean Production	39
3.1.4. Lists of Criteria	41
3.1.5. Quality Concepts	42
3.1.6. Schonberger's (1996) Sixteen Principles	46
3.2. The Contingent Approach	50
3.3. Conclusion	54
Chapter 4: The Relevance of Schonberger's Model to MTO Companies	55
4.1. The relevance of the underlying concepts	55
4.2. The detailed steps of the sixteen principles	59
4.3. Common assumptions that do not apply to MTO	64
4.4. The relevance of the sixteen principles to MTO	71
4.4.1. Principles that are applicable to MTO	71
4.4.2. Principles that are applicable with minor modifications	75
4.4.3. Principles that need major modification	79
4.4.4. Principles that are not applicable to MTO	88
4.4.5. Summary	88
4.5. Issues relevant to MTO not included in Schonberger (1996)	90
4.6. Conclusion	95
Chapter 5: Initial ideas for a new WCM model labelled "SHEN" for the MTO sector.	96
5.1. Overview of SHEN	96
5.2. The five step improvement scale	104
5.3. Detailed explanation of the first version of SHEN	106
5.4. Summary Table	133
5.5. Conclusion	136

Chapter 6: Case Study Data Collection	137
6.1. Company A	139
6.2. Company B	141
6.3. Company C	142
6.4. Company D	144
6.5. Company E	145
6.6. Company F	147
6.7. Classification of the companies and the replication logic	149
6.7.1. The replication logic	151
6.8. Conclusion	152
Chapter 7: Case Study Evidence from Small Sized MTO Companies	154
7.1. Case Study A	156
7.1.1. Initial assessment	156
7.1.2. The company response to the initial assessment	165
7.1.3. Final assessment	171
7.2. Case Study B	173
7.2.1. Initial assessment	173
7.2.2. The company response to the initial assessment	180
7.2.3. Final assessment	185
7.3. Conclusion	187
Chapter 8: Case Study Evidence from Medium Sized MTO Companies	190
8.1. Case Study C	190
8.1.1. Initial assessment	190
8.1.2. The company response to the initial assessment	198
8.1.3. Final assessment	204
8.2. Case Study D	207
8.2.1. Initial assessment	207
8.2.2. The company response to the initial assessment	215

8.2.3. Final assessment	220
8.3. Case Study E	222
8.3.1. Initial assessment	222
8.3.2. The company response to the initial assessment	228
8.3.3. Final assessment	232
8.4. Case Study F	234
8.4.1. Initial assessment	234
8.4.2. The company response to the initial assessment	241
8.4.3. Final assessment	245
8.5. Conclusion	246
Chapter 9: Adjusting the SHEN model in the light of the case study evidence	248
9.1. Issues that were verified.	249
9.1.1. Principle 1: Integrate the functions of production and marketing in all processes.	249
9.1.2. Principle 13: Gather customer feedback and benchmarking	250
9.2. Issues that were verified with changes in order/rank	252
9.2.1. Principle 3: Collaborate with customers.	252
9.2.2. Principle 4: Simplify the shop floor.	254
9.2.3. Principle 12: Improve quality and implement appropriate performance measures.	257
9.3. Issues that were modified	260
9.3.1. Principle 2: Design for products, processes and improved supplier relationships.	260
9.3.2. Principle 6: Improve scheduling and workload control to cut flow times.	264
9.3.3. Principle 7: Cut the start up/changeover time and improve preventive maintenance.	266
9.3.4. Principle 8: Improve information flow.	268
9.3.5. Principle 9: Make rapid improvements in skills and flexibility.	270
9.3.6. Principle 14: Promote/market/sell every improvement.	273
9.4. Issues that were merged	275
9.4.1. Principle 10: Have systematic rewards, recognition and monetary payment.	275

9.4.2. Principle 11: Everybody involved in change and strategic planning – to achieve a unified purpose.	276
9.4.3 Conclusion for the merged principle (Principles 10 & 11)	279
9.5. Issues that were dropped	280
9.5.1. Principle 5: Seek simple, flexible, movable, low-cost equipment in multiples.	280
9.6. The final version of the SHEN model	281
9.7. Conclusion	285
Chapter 10: Conclusions	286
10.1. SHEN as a practical tool to develop company improvement plans	287
10.2. Significant contribution to knowledge on MTO best practice	292
10.3. Areas for further research	293
References	295
Appendix 1: Questionnaires used to collect case study data	306
Appendix 2: Summary of levels achieved by the six companies	312

LIST OF TABLES

	PAGE
1.1 A comparison of MTO and MTS companies	8
1.2 The degree of product customisation	13
1.3 New Classification of non MTS	15
3.1 The relevance of other literature to Schonberger's (1996) WCM ideas	48
4.1 Toward Twenty- first Century Management of the Manufacturing Enterprise	56
4.2 The detailed five steps for each of Schonberger's (1996) Sixteen Principles	60
4.3 Summary of the relevance of Schonberger's Sixteen Principles to MTO Companies	88
5.1 SHEN categories and principles	98
5.2 The relationship between Schonberger (1996) and the SHEN model	99
5.3 The detailed steps of the first SHEN model	133
6.1 General background information on the companies in the survey	138
6.2 Classification of the MTO Companies based on the Amaro <i>et al.</i> (1999) Taxonomy	149
6.3 Types of MTO companies	151
7.1 Company A response to the initial assessment	165
7.2 Final assessment for Company A	172
7.3 Company B response to the initial assessment	181
7.4 Final assessment for Company B	185
8.1 Company C response to the initial assessment	199
8.2 Final assessment for Company C	204
8.3 Company D response to the initial assessment	216
8.4 Final assessment for Company D	220
8.5 Company E response to the initial assessment	229
8.6 Final assessment for Company E	232
8.7 Company F response to the initial assessment	242
8.8 Final assessment for Company F	245
9.1 Modification to Principle 3	253
9.2 Modification to Principle 4	256
9.3 Modification to Principle 12	259
9.4 Modification to Principle 2	263
9.5 Modification to Principle 6	266
9.6 Modification to Principle 7	268
9.7 Modification to Principle 8	270
9.8 Modification to Principle 9	272
9.9 Modification to Principle 14	274
9.10 Modification to Principle 10	276
9.11 Modification to Principle 11	278
9.12 New Principle 9 in the final SHEN model	279
9.13 The final SHEN model	282
Table A2.1: Summary of the case study evidence for Principle 1	313
Table A2.2: Summary of the case study evidence for Principle 2	314
Table A2.3: Summary of the case study evidence for Principle 3	315

Table A2.4: Summary of the case study evidence for Principle 4	316
Table A2.5: Summary of the case study evidence for Principle 5	317
Table A2.6: Summary of the case study evidence for Principle 6	318
Table A2.7: Summary of the case study evidence for Principle 7	319
Table A2.8: Summary of the case study evidence for Principle 8	320
Table A2.9: Summary of the case study evidence for Principle 9	321
Table A2.10: Summary of the case study evidence for Principle 10	322
Table A2.11: Summary of the case study evidence for Principle 11	323
Table A2.12: Summary of the case study evidence for Principle 12	324
Table A2.13: Summary of the case study evidence for Principle 13	325
Table A2.14: Summary of the case study evidence for Principle 14	326

LIST OF FIGURES

	PAGE
2.1 Deductive vs. Inductive Research	26
5.1 The derivation of the SHEN model	103
5.2 Marketing and Production divides	108
6.1 Time span between visits and the level of people interviewed at Company A	140
6.2 Time span between visits and the level of people interviewed at Company B	141
6.3 Time span between visits and the level of people interviewed at Company C	143
6.4 Time span between visits and the level of people interviewed at Company D	145
6.5 Time span between visits and the level of people interviewed at Company E	146
6.6 Time span between visits and the level of people interviewed at Company F	148
7.1 Summary - initial assessment for Company A using the SHEN model	157
7.2 Summary - initial assessment for Company B using the SHEN model	174
8.1 Summary - initial assessment for Company C using the SHEN model	191
8.2 Summary - initial assessment for Company D using the SHEN model	208
8.3 Summary - initial assessment for Company E using the SHEN model	223
8.4 Summary - initial assessment for Company F using the SHEN model	235

CHAPTER 1

INTRODUCTION

1.1. The need to aspire to be World Class

In response to the revolution in the world of manufacturing, many companies have begun to embark upon new ways of manufacturing practice. This response has been perceived to be necessary by manufacturers around the world, as it is thought that continuing to make process innovation and improvements is essential for survival in the current competitive environment (Heim *et al.* (1992), Prabhu *et al.* (2000)). These innovations and improvements have been given many labels including Lean Manufacturing, World Class Manufacturing (WCM), Total Quality Management (TQM) and Business Process Re-engineering (BPR). However, it is important to ask whether these labels are different labels for the same phenomena or whether they are different labels that signify different approaches. In other words, could they all come under one common banner, such as World Class Manufacturing (WCM), or are they totally separate?

“Lean manufacturing” alone has received much attention in the last decade since the idea was introduced by Womack, Jones and Roos (1990), (Jina *et al.* (1997)). According to Morton (1994), Lean manufacturing builds on the thinking and systems evolved by the quality theories. It is a way by which the business processes are “organised so as to

deliver products with greater variety and superior quality using less resource and in a shorter time than can be achieved by mass production methods” (Jina *et al.* (1997)). The label of Total Quality Management has also received much attention by many authors to describe best practice innovation (Morton (1994), Oakland (1993), Shores (1994)). An especially notable contribution to the total quality management literature is the work of Masaaki Imai in his book *Kaizen* (1986) (Morton, 1994). Kaizen is a fundamental philosophy of Japanese manufacture which also includes Total Quality Control and Just-In-Time (JIT) manufacturing. Together these philosophies provide a process for continuous improvement of everything in the business (Shores (1994)). Some authors view recent manufacturing concepts in the West as an emulation of the successful Japanese model. This phenomenon has been labelled ‘Japanisation’ (see Schonberger (1986), Morton (1994)). Morton (1994) argues that some of the Japanese manufacturing concepts and techniques can be adopted in Western Companies. A further label for the new manufacturing era is BPR (Hammer and Champy (1993), Shores (1994)). In BPR, it is thought that it is not the products but the processes that create products that bring companies long-term success (Hammer and Champy (1993)). They claimed that BPR is necessary for companies because of the speed of growth of the three ‘C’s, customer expectations, competition and change.

Some authors have claimed that all labels have the same purposes and can guide companies to improve both methods of operation and performance. For instance, Morton (1994) claimed that Lean Manufacturing, TQM, BPR, WCM all seem to be aiming to solve similar problems in the companies. They are all process-related activities and all

those labels are used to describe the world class concept. The term WCM has been used by several authors including Shores (1994), Kanter (1995), Flynn *et al.* (1997), Schonberger (1996), and Hendry (1998). Their ideas on WCM cover all the terms described above such as lean manufacturing, TQM and BPR. The term WCM therefore consists of activities including quality management, lean manufacturing, Just-In-Time (JIT), flexibility of workers, human resources, flexibility of machinery and many others. It can therefore be concluded that this label is one of the most “comprehensive” because it covers everything that has been described as best practice innovation mentioned above. In the research discussed in this thesis, WCM will be used as a term to describe company improvement programs, which have the aim of assisting companies in remaining competitive in the new manufacturing era.

However it is important to note that aiming to be ‘World Class’ in a more general sense is a somewhat nebulous aim. It is very difficult to define the best practices in the world at any point in time, and even if such a definition could be found, it would immediately become out of date. This thesis takes the stance that it is important to aim to be better, and that any improvement will take an individual company further along the journey to be world class. It does not try to help a company to identify whether or not it has reached this goal. Global competition increasingly requires manufacturing companies to make changes in terms of both operations and performance in order to be able to maintain its market position and to gain competitive advantage over its competitors. Therefore they need to be able to identify appropriate innovation techniques to implement.

Nevertheless, to implement any of the possible operations improvement as described above is not an easy task. Whilst some such improvement activities are a great success, others fail to achieve the expected changes and lead to the question of whether they are essential if the company concerned is to continue on its journey towards the world class goal. If they are not essential for certain companies, then it may be that the various different labels to describe the current best practice manufacturing system makes the guidelines on which appropriate labels to follow is becoming somewhat confused. In particular, it may be that some of the ideas in the literature do not work as well as the literature suggests in some circumstances. Alternatively, it may be that the root causes of failure in applying the WCM concepts are not that they are ineffective but the company may have a lack of understanding of why these concepts are important and how to implement them. Either way, proper guidance is needed for the company to determine which of the many innovations on offer are applicable to its particular manufacturing environment.

1.2. The relevance of WCM research to the Make to Order sector

The advice currently available on making company changes includes the universalistic approach (Kanter (1995), Todd (1994), Shores (1994), Schonberger (1986, 1996), Markland *et al.* (1998)), and the contingent approach (Sousa & Voss (1999), Jina *et.al* (1996), Benson *et al* (1991), Hendry (1998)). The universalistic approach assumes that the WCM advice is appropriate to all kinds of companies; whilst the contingent approach claims that there is no single WCM approach that will work for all companies.

The idea that WCM is universally applicable assumes that all industrial sectors can be treated the same and discusses the WCM concept in general terms without making any explicit reference to company type. Authors such as Todd (1995) define WCM as being the best in your field in the world; Hayes *et al* (1988) and Markland *et al* (1998) emphasise the need to have the capability to be a superior competitor; Giffi *et al* (1990) aver that customers and quality aspects are the focal points of WCM; Defillipo (1997) emphasises the customer as the primary focus of WCM and Jesitus (1998) argues that WCM levels require an overall willingness to establish closer connections with everyone from customers and suppliers to workers; an unwavering commitment to self-analysis and improvement, and an aggressive approach to technologies that can help turn visionary strategies into gold-medal realities. Definitions of this type are extremely general, and whilst they might provide high level planning guidance, they do not aim to provide detailed operations advice. Where the latter is attempted, this too tends to be universalistic rather than being applied to any specific company type.

The idea that one WCM concept cannot be universally applicable is now being argued in the literature by authors such as Sousa & Voss (1999), Jina *et.al* (1996) and Benson *et al* (1991). For example, Sousa & Voss (1999) investigate whether there is a link between a plant manufacturing strategy and the pattern of use of best practices related to quality issues and found that the choice of procedure was indeed contingent upon the type of company. Jina *et al.* (1996) show that lean manufacturing procedures need to be adapted if they are to be applied to firms which they describe as ‘high variety low volume’

producers. Benson *et al.* (1991) also cast doubt on whether aspects of quality management are applicable to all sectors. However, none of these authors look at the WCM concept in the broader context covered by more general authors such as Schonberger (1986, 1996) and have therefore not attempted to produce a comprehensive new concept for alternative manufacturing sectors. Hendry (1998) presents a more thorough review of the literature, illustrating areas in which the general advice available, on becoming WCM and on other improvement programmes, does not apply to one particular sector of industry, the Make to Order companies. She argues that a universalistic approach to WCM practice is unhelpful for companies in the Make to Order sector. In order to explain why the universalistic approach may not be appropriate, it is important to describe the characteristics of the Make to Order sector and distinguish between this sector and the more common Make to Stock sector.

1.2.1 The differences between Make to Stock (MTS) and Make to Order (MTO)

Given modern manufacturing philosophies and the ability to reduce lead times, the use of finished goods inventories is declining in some manufacturing sectors. This has meant that the labels MTS and MTO are becoming a little confused as the MTS label is somewhat inappropriate for some mass producers and mass customisers that now claim to manufacture goods on a 'make-to-order' basis, holding little, if any, finished goods inventory. However, the MTS operation remains distinct from MTO as the products in MTS companies are designed by the company prior to receiving the customer orders. They are mostly standard products that can be produced in large quantities and stocked if

it is economical to do so. The customer may purchase the product directly from inventory at a retail outlet or at the factory distribution centre. In some cases, products can be modified according to a customer requirement, and therefore are not produced until an order is placed, but nonetheless there is a large degree of similarity between products. In contrast, the MTO company manufactures a wider variety of products in relatively low volumes. Products are always manufactured to customer design and specification and therefore the production can only start after the customer places an order, as instruction from the customer is required. Even where the company specialises in a type of product, the volumes are low even at the component production stage as the product size and material specifications tend to vary enormously. To win an order, the company has to compete with other companies on the basis of price and the delivery date. Hendry *et al.* (1993) claim that in some cases the customer may specify the price he is willing to pay and ask whether the manufacturer can do it and what would be the delivery time, or the customer may specify a delivery time and ask for a price, or ask for both. Table 1.1 compares some of the characteristics of the two groups MTO and MTS as set out by Hendry *et al.* (1993), Hill (1993, 1995), and Amaro *et al.* (1999).

Given these distinct differences, it is clear that companies in the MTO sector will need to use different operations processes than those in the MTS sector. Yet much of the universalistic literature assumes that all companies should adopt practices that apply to MTS. Therefore there is a need to develop a set of WCM advice that is aimed at the MTO sector specifically. In order to do this, it is first necessary to develop an understanding of this sector of industry.

Table 1.1: *A comparison of MTO and MTS companies*

MAKE TO ORDER COMPANIES	CHARACTERISTICS	MAKE TO STOCK COMPANIES
Few standard products	Product or customer families	Product/family focus
Few regular customer	Customers	Having regular customers
Many suppliers	Suppliers	Few suppliers
Multi-task machinery and flexible workforce	Resources	Specialist machinery and workforce
Demand is volatile and can rarely be predicted	Product Demand	Demand for standard products can be forecast
Based on receipt of customer orders. Cannot be planned in advance.	Capacity Planning	Based on forecast demand. Planned well in advance. Adjusted later if necessary
Vital for customer satisfaction. Agreed with customer	Production lead times	Unimportant to customer. Can be set internally
Negotiated with customer before production	Prices	Fixed by the producer

1.3. The diversity of the MTO sector

MTO companies have many special characteristics and comprise a complex sector that cannot just be grouped into one. The following section classifies MTO companies into several types, and describes the characteristics of each type.

1.3.1. The differences between ATO and MTO/ETO

One way to classify non MTS companies is by looking at the amount of processing the product required after the company receives the customer order. At one end of the spectrum is the Assemble-to-order (ATO) company. These companies manufacture a fairly standard product or option module, according to its demand forecast and then assemble a specific combination or package of modules after receiving the customer's order. At the other end of the manufacturing spectrum is the MTO company. This company does not begin processing the material for and components of the product until it has received an order from a customer.

In an ATO environment, the companies usually produce end items with many options from relatively few major assemblies and components, after customer orders are received. This approach addresses two competitive priorities, customisation and fast delivery time. The classic example is the car manufacturer (see Markland *et al.* (1998)). Operations hold the major assemblies and components in stock until a specific order comes in. After receiving orders from a car dealer, the manufacturer specifies the exact

build schedule for the automobiles. The schedule is based on the options ordered by the customers – engine types, transmission types, air conditioning, standard versus digital control panel, leather cloth, interior options and so on. The many components of assembling the automobiles would have been ordered or started into production before receiving the dealers' orders based upon demand forecasts (Markland *et al.* (1998)). Hence, the major operation that remains after the order comes in is assembly.

In the MTO environment, the firm does not begin processing the material for and components of the products until after it receives the order. This approach provides a high degree of customisation. The company competes on the basis of product customisation and serves its customer base by providing unique and/or highly specialised items. MTO operations cover a range of activities. In the pure engineering-to-order company (ETO), the order arrives before the design stage (Kingsman *et al.* (1993)). The customer normally describes the functions and characteristics required in the product they have. The company has to produce a design and specification. The customer order may be for just the design stage or for both design and manufacture. These companies usually make one-off products. Another type of company is the sub-component MTO company, where the customer may supply the design and it is only necessary to configure how to make it with the machines and skills in the company (Kingsman *et al.* (1993)).

In these MTO/ETO companies, every order may be very dissimilar to the others. These companies may sell a skill to perform certain types of operations rather than selling actual products. In this case there may still be some repeat production for the same customer

and the provision of spares. Alternatively the company may offer a variety of specialist products and allow varying degrees of customisation of the components (e.g. safety doors – bullet proof, sound proof). However every thing that is made by this type of company is only made after the order has been accepted.

However the general classification above is not enough to explain all types of non-MTS manufacturing operations. A more detailed classification of the manufacturing operations comes from Hill (1993) who categorised the non-MTS operations into five types as given below:

“Design to order – new product response where companies design and manufacture a product to meet the specific needs of a customer;

Make to print - some customers require companies to make-to-print (i.e. make a product in line with a given drawing). In such markets, lead-times only include raw-materials purchase/ supply and manufacturing. They do not include design but some customer –induced redesign during the process will often be involved;

Engineer-to-order – changes to standard products are offered to customers and only made to order. Lead times include the relevant elements of engineering design and all manufacturing;

Make-to-order – concerns manufacturing a standard product (any customisation is nominal and does not increase total lead-times) only on receipt of a customer order or against an agreed schedule or call off;

Assemble to order- components and sub-assemblies have been made to stock. On receipt of an order (or against an agreed schedule or call-off) the required parts are drawn from work in progress/component inventory and assembled to order.”

Unfortunately Hill (1993) uses the terms ETO and MTO with different meanings from those more commonly used in the operations literature, which is a major disadvantage of his framework (Amaro *et al.* (1999)). Hill’s (1993) definition of MTO and ETO is concerned with the manufacture of standard products only on receipt of a customer order or against an agreed schedule, whilst most of the literature describes MTO and ETO companies as producing highly customised products.

1.3.2. Amaro et al.’s (1999) taxonomy of MTO companies

Thus, Amaro *et al.* (1999) presented a more detailed taxonomy of the non-MTS companies based on three major dimensions as below:

1. The degree of product customisation either; pure, tailored, standard and non-customisation. (Refer to Table 1.2).

Table 1.2: *The degree of product customisation*

<i>Pure</i>	<i>Make a new design</i>
<i>Tailored</i>	<i>Change/modification to an existing design</i>
<i>Standardised</i>	<i>Choose from a set of design options</i>
<i>Non-Standard Product</i>	<i>Take existing design as is</i>

Pure Customisation: A design developed from scratch for each customer. The customer notifies the characteristics and specifications he wishes to have. The company then has to produce a design based on specifications given by the customer. Irani *et al.* (1997) claim that to produce these products a highly flexible production capability is required, which implies versatile manufacturing equipment and multiskilled employees, both of which must be capable of performing many different tasks. They do not have a standard product range but maintain competitive advantage by selling their engineering capabilities (Kingsman *et al.* 1993).

Tailored customisation: The products manufactured are based on modifications of an existing design or original design. The customer typically needs to describe the specification of the product to the firm. The modification may be in the form of changing the size or changing the processing capacity whereby the existing design remains.

Standardised customisation: Under this category, final products are provided through modular design in which various features can be added or removed from the basic design. The customer has to select a design from existing design options and then recapitulate any features he needed (either added or removed). In this environment, all processing work such as production routing, specification and design have all been determined.

Non-customisation: Where the manufacturer only produces products based on an existing design as is. An obvious reason for doing this after receipt of a customer order is that this is cheaper for expensive products for which there is an irregular, low demand.

2. The second dimension is the company responsibility for design, specification and the purchasing of materials. In some cases the customer provides all the design, specification and the purchasing. The term design refers to the fundamental idea of the product, often a rough set of drawings. Specification means a detailed drawing to support production and also the list of both technical requirements and of material to use.

3. Thirdly based on activities performed after receipt of an order. The list covers delivery, assembly, processing, routing, specification and purchasing. Routing means the path the product will follow in the shop floor and which machines to use and in which sequence.

Based on the Amaro *et al.* (1999) taxonomy, MTO companies can be classified into eleven types as shown in Table 1.3. To date, the Amaro *et al.* (1999) taxonomy on MTO companies presents the most complete definition of MTO, illustrating the types of MTO based on three dimensions. Therefore Amaro *et al.*'s (1999) taxonomy will be used to describe the MTO companies in this research. The MTO label, for the remaining sections of this thesis, will be used to describe the generic MTO manufacturers that cover ETO1 through to MTO3; ranging from pure, tailored to standardised customisation. It does not embrace any of the ATO companies, nor any companies that manufacture a standard product, even if that product is produced after the receipt of a customer order.

Table 1.3: *New Classification of non MTS*
(Cited from Amaro *et al.* (1999))

The Classification Categories	ETO 1	ETO 2	ETO 3	ETO 4	MTO 1	MTO 2	MTO 3	MTO 4	MTO 5	ATO 1	ATO 2
<i>Degree of customisation</i>											
Pure	/	/	/	/							
Tailored					/						
Standardised						/	/			/	
None								/	/		/
<i>Company responsibility for</i>											
Design	/				/	/	/	/	/	/	/
Specification	/	/			/	/	/	/	/	/	/
Purchasing	/	/	/		/	/	/	/	/	/	/
<i>Activities After Receipt of Orders</i>											
Delivery	/	/	/	/	/	/	/	/	/	/	/
Assembly	/	/	/	/	/	/	/	/	/	/	/
Processing	/	/	/	/	/	/	/	/	/		
Purchasing	/	/	/		/	/		/			
Routing	/	/	/	/	/						
Specification	/	/			/						
Design	/										

1.3.3. Repeat Business Customisers (RBC) and Versatile Manufacturing Companies (VMC)

Amaro *et al.* (1999) also argued that MTO companies can be split again by another dimension. This dimension is concerned with whether companies are involved in bidding for one-off orders or for a series of similar orders. “Repeat Business Customisers” (RBC) is used to describe a MTO firm who has to enter a bid once only for a series of similar orders. “Versatile Manufacturing Companies” (VMC) is used to describe companies in the alternative type of market in which each order is for a one-off product or one-off buying decision.

The RBC market “is the one where the competitive tender is to design and produce a product to meet regular and repeated need for a reasonable period into the future” (Amaro *et al.* (1999)). The competition and customisation is only during an initial customer purchase decision. After that, based on the agreement to supply the contract, the customer will place repeated orders with the same supplier. Generally RBCs are producing low product variety and have a small number of customers but high volumes per product.

In the VMC market, every order is considered as an individual independent buying decision. The customers send every order as an enquiry to a group of potential suppliers regardless of whether it is for a new design of product or a standard product that has been bought before. To win an order, the company has to determine a price and a delivery lead-time to quote as an individual bid in response to each customer enquiry. “Each order generally requires different amounts of processing at its work centres and in a different

sequence. These companies have to show versatility in their marketing, production planning, use of resources etc. over time in order to survive” (Amaro *et al.*(1998)). Normally, VMC companies manufacture high product variety in low volumes.

In this thesis, the term MTO will be used to encompass both RBC and VMC companies.

1.3.4. Small and Medium Sized Enterprises (SMEs) in the MTO sector

Many MTO companies in the United Kingdom are categorised as SME (Tobin *et al.* (1988)). Of course, there are also many large companies in this sector of industry. However, given that the needs of SMEs are distinctly different to those of larger enterprises (Hsu *et al.* (2000), Knight (2000)), it was decided to narrow the focus of the research. According to a recent CBI trends survey, small and medium sized enterprises outperformed the rest of the UK’s manufacturing industry in terms of employment and output over the past 4 months (Anonymous (1996)). Therefore, SMEs were chosen as this is an important sector.

1.4. Research objectives and questions

This study is undertaken with the objective of developing a new WCM model that can be implemented in the MTO sector. The model is concerned with the actions that a MTO company must take if it is to take its operations process forwards towards the world class goal. The purpose is to assist companies to determine how to improve their

manufacturing performance and practice, in order to continue to be competitive in a global market.

The main research questions are:

What are the pertinent components of a WCM model that would help companies in the MTO sector to identify and prioritise ways to improve their company performance?

Given the diversity of the MTO sector, is it sufficient to develop one WCM model, or is more than one model needed to cover most of the common characteristics of MTO companies?

This research question arose because a study of the literature (Hendry (1998)) showed clearly that the models currently available did not meet the needs of this sector of industry. This includes advice given in material readily available to companies such as the UK DTI brochures and texts. Given the complex nature of the MTO sector, it could be argued that it is necessary to build more than one WCM model. However it was decided that there are enough common threads to make it worthwhile to look for one model for the whole sector initially. However, in doing so, it was decided that it would be necessary to try and encompass issues for RBC and VMC companies whilst also covering the companies in the range from ETO1 to MTO3 as set out by Amaro *et al.*(1999).

1.5. Structure of this thesis

The thesis is structured as follows:

Chapter 2 addresses the methodology of the research, in the context of the many alternative methodologies commonly encountered in the literature. This research relies on the case study approach and therefore a review of case study research will be brought into the discussion.

Chapter 3 presents an overview of the many general WCM concepts which have been proposed in the literature. The discussions are based on general ideas of WCM using the universalistic approach and the contingent approach.

Chapter 4 reviews the WCM research presented by Schonberger (1996), in more detail. This includes a discussion of Schonberger's (1996) principles showing which principles are applicable to both MTS and MTO, which are applicable to MTO with some modifications, which are applicable to MTO with major revision, and finally those that are not applicable to MTO companies at all.

Chapter 5 presents the first version of the new WCM MTO model developed in this thesis. The MTO model proposed in this chapter was developed by combining several literature sources with the relevant and/or modified material from Schonberger (1996).

Chapter 6 discusses the six MTO case study companies involved in the study. The chapter categorises the companies using the classification by Amaro *et al.* (1999). The case study evidence seeks to determine whether the initial version of the new WCM model, as discussed in chapter 5, includes the features required by the MTO sector.

Chapter 7 provides case study evidence from small sized MTO companies. For each company, a two-stage analysis was performed. In the first stage, to verify the data collected as much as possible, several people were interviewed at each company level where appropriate. The second stage of the analysis was to visit the company to discuss a report which summarised the findings from the interviews. In this stage, only one meeting was proposed at the senior management level. **Chapter 8** provides similar case study evidence from medium- sized MTO companies.

Chapter 9 presents the final version of the new WCM MTO model once the modifications suggested by the case study evidence have been incorporated. Finally **chapter 10** presents the main conclusions of the research, its contribution and suggestions for further work.

CHAPTER 2

RESEARCH METHODOLOGY

This chapter aims to describe the research approach and the framework used in the study. The first part of the discussion will be dedicated to the diversity of research methodology commonly encountered in the literature. This is followed by a description of the triangulation concept that is used in this research. This research relies on the case study approach and therefore a review of case study research will be brought into the discussion. Finally, the data sources used will be described.

2.1. Management Research Perspective

There is a long-standing argument about the most appropriate philosophical position from which management research methods should be derived; positivism or phenomenology. Easterby-Smith *et al.* (1997) argue that “the key idea of positivism is that the social world exists externally, and that its properties should be measured through objective methods, rather than being inferred subjectively through sensation, reflection or intuition”. It seeks facts or causes of social phenomena, with little regard to the subjective state of the individual. Therefore “logical reasoning is applied to the research so that precision, objectivity and rigour replace hunches, experience and intuition as the means of investigating research problems” (Hussey *et al.* (1997)).

Positivism is founded on the belief that the study of human behaviour should be conducted in the same mode as the study of the natural sciences. It is based on two assumptions, firstly reality is independent of us and exists regardless of whether we are aware of it and secondly, that knowledge is only of significance if it is based on observations of this external reality. Thus, this approach serves primarily to test a theory, in an attempt to develop an understanding of that phenomenon. Hussey *et al.* (1997) outline the positivistic features as using quantitative data, large samples, hypothesis testing, data is highly specific and precise, reliability is high and it is possible to generalise from sample to population.

In contrast with the positivist, there is another school of thought: namely the phenomenological. According to Hussey *et al.* (1997), the phenomenological methodology developed as a result of criticisms of the positivistic methodology. The main criticisms of the positivistic methodology as described by Hussey *et al.* (1997) are as follows:

- It is impossible to treat people as separate from their social contexts and they cannot be understood without examining the perceptions they have of their own activities;
- A highly structured research design imposes certain constraints on the results and may ignore more relevant and interesting findings;
- Researchers are not objective, but part of what they observe. They bring their own interests and values to the research;

- Capturing complex phenomena in a single measure is, at best, misleading. For example, is it possible to assign a numerical value to a person's intelligence?

Cited from Hussey *et al.* (1997)

Phenomenology is known as the science of phenomena. Some researchers label it as qualitative approach. A phenomenon is a 'fact or occurrence that appears or is perceived, especially one of which the cause is in question' (Allen (1990)). It is concerned with understanding human behaviour from a participant's own frame of reference. The key features of the phenomenological methodology, as described by authors including Easterby-Smith *et al.* (1997), Gill *et al.* (1997), Hussey *et al.* (1997), Saunders *et al.* (2000), are summarised as;

- Using qualitative data;
- Uses multiple methods to establish different views of phenomena;
- Uses small samples; investigated in depth or over time;
- Concerned with generating theories – develops ideas through induction of data.

The research presented in this thesis comes into the phenomenological category. It will be based on methods associated primarily with qualitative data, as the research is concerned with 'how' and 'why' of WCM. 'How' is associated with the way to improve the manufacturing performance and practice and 'why' is to find out why one method works for a particular company type but not for another. In particular, the research looks at why some methods work for the MTO sector rather than the MTS sector. Multiple methods are used to establish different views of phenomena in the

research. Some authors including Denzin (1970), Easterby-Smith *et al.* (1997), Gill *et al.* (1997), describe this approach as triangulation. Triangulation refers to the combination of methodologies in the study of the same phenomenon. Easterby-Smith *et al.* (1997) categorised triangulation into triangulation of theories, triangulation of data, triangulation by investigators and methodological triangulation as follows:

- *Triangulation of theories* means borrowing a theory or model from one discipline and using them to explain phenomenon in another discipline;
- *Data triangulation* is where data is collected at different time frames or from different sources to explain the phenomenon;
- *Triangulation by investigators* is where data is collected by different people on the same phenomenon and the results are then compared;
- *Methodological triangulation* is where the researcher uses both qualitative (inductive) and quantitative (deductive) techniques including questionnaires, interviews, telephone surveys and field studies.

The triangulation used in this study is “methodological triangulation”, a mixture of deductive theory development and the inductive approach in which the data is used to inform the theory and to develop the theory further through case study research. The following section discusses in detail the triangulation methodology used in this study.

2.2. Methodological Triangulation

There are good reasons for using different methodologies in the same study. One of the reasons is that the use of different methods to study the same phenomenon can lead to greater validity and reliability than a single methodological approach. Gills *et al.* (1997) argue that “multiple and independent methods ..., if reaching the same conclusions, have greater validity and reliability than a single methodological approach to the problem”. It strengthens qualitative research findings by combining interviews, documentary sources and participant observation (Hammersley and Atkinson, 1983). Abrahamson (1983) points out that this kind of research “prevents the research becoming method-bound: the strength of almost every measure is flawed in some way or other, and therefore research design and strategies can be offset by counterbalancing strength from one another”. Triangulation has fundamental strengths, persuades productive research, enhances qualitative methods and allows complementary use of quantitative methods (Jick (1979)).

2.2.1. Deductive VS inductive

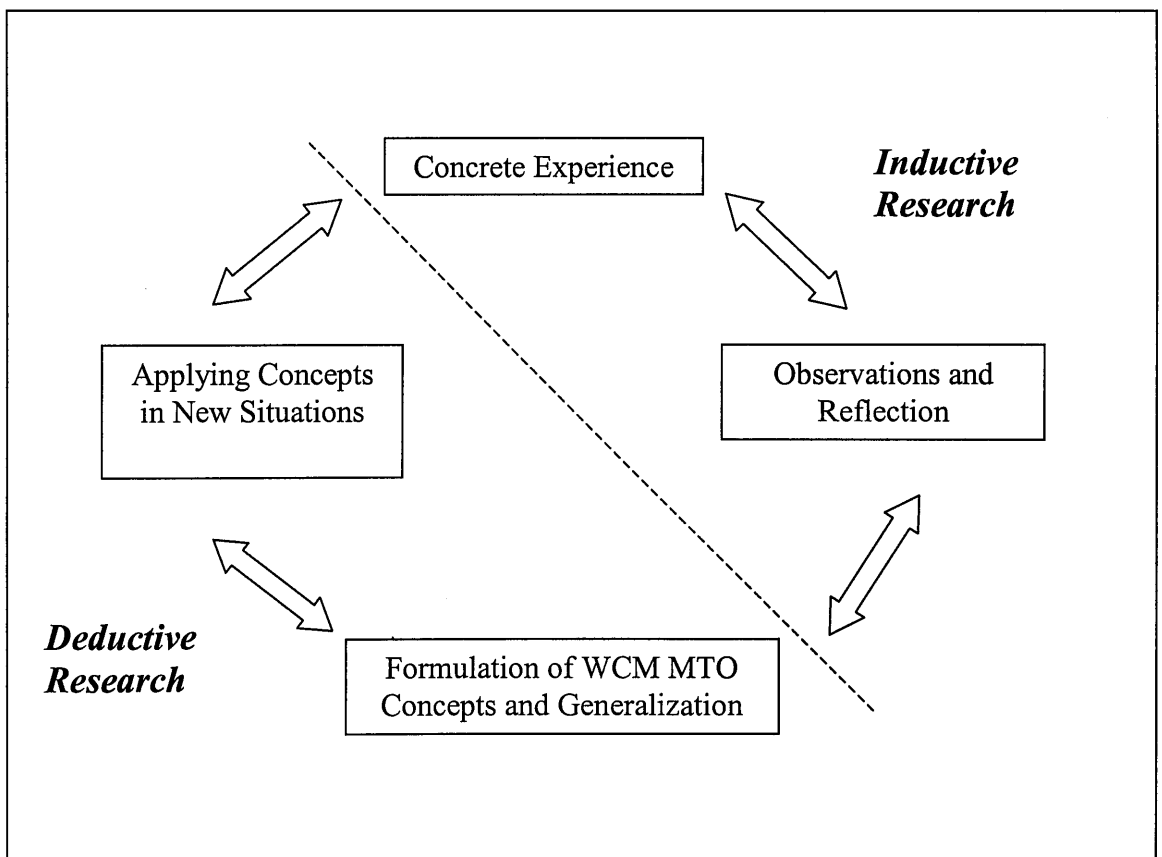
In this study the triangulation (the mixture of deductive and inductive) approach is used in the research as described in the next section. The deductive research method is concerned with the development of a conceptual method and theoretical structure prior to its testing through empirical observation. In using this method, the researcher will first need to start with a concept or framework, utilising existing theory, and then test the adequacy of the framework as a means to explain findings. “If the pattern of

the data matches that which has been predicted through the conceptual framework you will have found an explanation” (Saunders (2000)).

In this research the initial WCM MTO model is developed using the deductive approach. The model was developed using evidence from the literature and the author’s experience, to determine the issues which were relevant to the MTO sector.

As illustrated in figure 2.1 to the left hand side of the Kolb’s experiential learning cycle, the work began with abstract conceptualisation and then moved on to applying the concepts in new situations so as to create new experiences or observation.

Figure 2.1: *Deductive vs. Inductive Research*
(Based on Kolb’s experiential learning cycle, 1979)



On the other hand the inductive method corresponds to the right-hand side of Kolb's learning cycle in Figure 2.1. It is concerned with learning by reflecting upon particular past experiences and through the formulation of abstract concepts, theories and generalisations that explain the past, and predict the future.

In contrast to the deductive approach, theory is the outcome of inductive research. Perhaps the most famous inductive view provided by Strauss and Corbin (1990) is known as Grounded theory. In Grounded theory the qualitative researcher begins with a research question and the theory develops during the data collection process. Research data is collected to determine how the literature and data compare. According to Strauss and Corbin (1990) Grounded theory is a qualitative research technique that uses a "systematic set of procedures to develop an inductively derived theory about a phenomenon". Chetty (1996) avers that Grounded theory is ideal for studying causality (cause and effect) because its questions are based on action and process.

Nevertheless, the use of the complete inductive approach is less appropriate for this research. This is because in the inductive approach, the qualitative researcher needs to begin with a research question and the theory develops during the data collection process. This is in contrast with this research whereby an initial theory is developed before the data collection process.

The inductive approach is used to modify the proposed model during the case study process. The inductive methods of research including case study observation, interviewing, and documentation are used for this part of the research.

2.3. Case Study Research

To further develop the model an inductive case study approach has been used extensively. A case study is an extensive examination of a single instance of a phenomenon of interest and is an example of the inductive approach. Bonoma (1985) refers to case studies as research that investigates a phenomenon in its natural setting to get information from groups, people or firms. Eisenhardt (1989) refers to the case study as “a study that focuses on understanding the dynamic present within a single setting”. A case study technique implies a single unit analysis, such as a group of workers, a company, an event, a process or even an individual (Hussey *et al.* (1997). It is concerned with gathering information about the unit of analysis, frequently over a very long period of time, with a view to obtaining in-depth knowledge. Yin (1993) claims that case studies have been used in many research contexts including business and organisational issues, education, child development and youth policy, family studies, international affairs, evaluation, technology development and research on social problems. Yin (1993) defined the case study method as “ an empirical enquiry that investigates a contemporary phenomenon within its real-life context, addresses a situation in which the boundaries between phenomenon and context are not clearly evident, and uses multiple sources of evidence”. Case studies help researchers connect the micro level to the macro level, or the actions of individual people to the large scale social structures and processes (Vaughan (1992)). Case studies “are often described as exploratory research, used in areas where there are a few theories or a deficient body of knowledge” (Hussey *et al.* (1997). Neuman (1997) claims that these methods require researchers to spend several hours in direct personal contact with

those being studied. The investigator does this by getting to know a particular social setting and seeing it from the point of view of those in it. The researcher also shares the feelings and interpretations of the people he studies and sees things through their eyes (Neuman (1997)).

2.4. Why Case Studies?

In this research it was decided that case study research would be more appropriate than a larger empirical study because explanation is needed as much as evidence. It is not enough to discover what companies are currently doing and how they believe they can improve. Rather, it is necessary to explore within the managerial level whether certain improvements are possible, discovering the reasons for any issues in which the initial model conflicts with the opinions of company personnel. Also, given the number of issues involved in the study, a postal questionnaire would have been prohibitively long and it was thought better to interview company personnel. In commencing the collection of case study evidence, it was expected that the results would show areas in which the initial WCM model could be usefully modified to make it more appropriate to the MTO sector.

Chetty (1996) argues that a single case study method has been used regularly and a multiple-case study method has only become popular recently. Strauss and Corbin (1990), Eisenhardt (1989) and Yin (1989) mention the importance of multiple cases in research work. For example Eisenhardt (1989) claims that the multiple case study approach encourages the researcher to analyse patterns common to cases and theory and to avoid chance associations. Multiple case studies are a powerful means to

generate theory because they permit replication and extension among individual cases (Eisenhardt (1991)). Chetty (1996) asserts that having multiple data collection will give advantages as follows:

- It can prevent subjective bias. Any finding or conclusion in a case study is thus supported by a chain of multiple evidence from different sources, and is therefore more convincing and accurate than a finding or conclusion from a single study;
- It allows the researcher to conduct a more thorough examination of the phenomenon than is possible with a single study.

In this study, it was decided that the multiple case study approach should be used and six MTO companies were selected. According to Eisenhardt (1989) there is no ideal number of cases in the multiple case approach. She argued that a study of between four to ten cases works well. If the number of cases is less than four, theory would be difficult to generate, but with more than ten cases the volume of data is difficult to cope with.

Conducting case study research involves selecting appropriate tools in order to collect data efficiently. One of the significant features of the case study method is the inclusion of multiple forms of data collection. These include documentation, archival records, interviews, direct observation and physical artefacts. The forms of data that relate to this case study research will be discussed in detail below.

2.5. Data sources

The data collected for this case study research comes from several sources including interviews, observations and documentation. As concluded by Benbasat *et al.* (1987), almost all case study research uses interviews for data collection. Half of the studies use interviews incorporated with other methods, such as documentation and observations. The rest relied solely on interview.

For each case study company, interviews were carried out with top level management, shop floor workers and intermediate management levels, such as the foreman or works manager. Prior to the interview process it was always necessary for the author to contact the company to present himself and the research topic to the contact person within the company. Contact with companies was found to be a very difficult task. This is because the interviews involved the top-level manager. So the process of contacting a company normally started through a member of staff of the university, and required telephone calls and letters explaining the research interests. Normally some of the key persons within the companies were identified during the initial contacts. Whenever possible it was arranged with the first contact person for him/her to introduce the research and the researcher to other key persons before the interviews.

These interviews were based on a carefully prepared set of semi-structured questions. The benefit of semi-structured questions is that it allows the researcher more freedom to explore beyond the answers in order to extend the clarification on any answers given. Semi-structured interviews “offers some flexibility, and allowing the views of

the interviewee to become known” (Easterby-Smith (1997)). Furthermore, “the semi-structured interview can expand on issues raised by the interviewees” (Fielding (1988)).

The semi-structured questions designed for the interviews are shown in Appendix 1. These questionnaires were developed in two stages. Firstly an initial questionnaire was carefully constructed to ensure that all the topics covered in the initial WCM model were included in order to gain all the required information and explanation on the companies’ current practice and their potential improvements. Secondly, the questions were modified slightly after the interviews had been carried out at the first case study company. This was necessary because the questions regarding performance measurement did not lead to sufficient information on this topic. Therefore these questions were modified so that adequate data was collected at the remaining companies. For the first case study company, the missing data was collected at a subsequent visit to the company and so that data set was complete also.

It is important to note that although pilot studies are recommended in the literature by many authors, including Janesick (1994), Bryman (2001), Burton (2000), in this case a pilot study was not carried out. As the data from the first case study was almost complete, it was felt that it would be worthwhile collecting the missing data and using this company as one of the cases. Collecting such data at a later date did not lead to any problem with the quality of data or the subsequent analysis in this case. If there had been more changes to the questionnaire after the first study, then the data from this company would not have been used but rather would have constituted a pilot study.

Data were recorded by both ‘note-taking’ and tape recorders during the interviews. In each case, the interviewee was asked whether or not they were happy for the meeting to be tape-recorded. Amazingly all the interviewees agreed to “tape-recorded” discussions. The advantage of the tape-recording process is that it can provide a full description of what has been said. After the interview, the recorded conversation was typed into the computer during the transcribing process. Nevertheless there were some problems during transcribing. Some arguments are not clear because there was too much noise from the machines on the shop floor. Hence as mentioned earlier, instead of relying wholly on tape recorders, the researcher also relied on ‘note-taking’.

A second source of data was observation. This was required to get a clear picture of how the factory operates. The researcher also used the factory visits to observe the shop floor environment, the kind of products produced and the production procedures in the company. The period of observation spanned between one to three hours. During observation, the researcher spent time walking around the plant with the manager and sometimes stood casually talking to the shop floor workers. The talking was tape-recorded. Nevertheless due to the noise of factory work some of the recordings cannot be heard. In this situation the researcher relied on “note-taking” data and memory at the time events occurred.

Finally the researcher gained access to documentary material such as, company newsletters, sales contracts, delivery documents, customer orders, scheduling and so on. Much of this material was confidential and obtained from the top management level only.

2.6. Conclusion

This chapter explains that this research takes a predominantly phenomenological perspective by collecting qualitative data from six case studies and by using multiple methods of research. The main methods are the deductive approach to develop an initial model of WCM for the MTO sector using the existing literature; this is then followed by the inductive approach in which data is collected from the case studies in order to develop the model further.

CHAPTER 3

A LITERATURE REVIEW OF THE WORLD CLASS MANUFACTURING CONCEPT

The WCM concept seems to appear frequently in books and journals as a term used to describe industrial success. This WCM term is not only used by many business authors, but it is also used by a lot of people in companies, large and small, throughout the world. As mentioned in Chapter 1, there are two approaches to the WCM concept. The first falls under the concept of the universalistic approach, that is, the concept is assumed to be applicable to all kinds of industrial sectors. In other words, the literature assumes that all the WCM advice given is relevant to all manufacturing types. The second approach, referred to as the contingent approach, is averred by those who believe that one WCM concept is not universally applicable. (Refer to Sousa & Voss (1999), Jina *et.al* (1996) and Benson *et al.* (1991)). Instead they argue that best practice will vary according to company strategy and the general manufacturing environment.

This chapter presents a literature review of the WCM concept. Section 3.1 starts with discussion on the general ideas of WCM under the universalistic approach. Section 3.2 discusses ideas from the contingent approach and finally section 3.3 provides the concluding section of this chapter.

3.1. The universalistic approach

The literature and empirical studies have cited a number of WCM concepts, but many of them begin by giving a general definition or a list of criteria or aims to define whether WCM has been achieved. According to the New Webster's Encyclopaedic Dictionary of the English Language (1997) world-class means "ranked among the world's best". The British Department of Trade & Industry, M90's series of booklet (1990) defines world class as:

"can compete with the best anywhere in the world".

The definitions above are universally applicable and are rarely disputed. However some would question what is meant by the expressions "best in the world", "ranked among the world's best" and "can compete with the best". For example, Hendry (1998) argues that definitions of this type are unhelpful for those who seek to improve their manufacturing performances. Jim Todd (1994) defines "world class as being the best in your field in the world". However it must be supported by a combination of good product design, good quality, low manufacturing cost, shorter lead-time, and reliable delivery performance and customer service.

3.1.1. Superior competitor

Some authors such as Hayes, Wheelwright, Clark (1988), Heim *et al.* (1992), Markland, Vickery, Davis (1998) put the emphasis on the capability of being a superior competitor to define WCM. Heim *et al.* (1992) define the world class

manufacturer as the one that has established an operating goal to be the best in the world. In order to be the best they review their attainment by benchmarking themselves against their competitors and against other world-class companies, including those in other industries. Markland *et al.* (1998) define the WCM company as being a superior competitor, who outperforms its major competitors in at least one aspect of competitive performance that is valued in the marketplace (e.g., product quality, customer service, delivery speed). Other authors such as McClenahan (1999) argue that world class status is achieved if the company can do better than its competitors. A company can do this by benchmarking itself against its current competitors and estimating, to the best extent possible, the capability of potential new competitors.

3.1.2. Customer Focus

Some authors emphasise ‘customers’ as a primary focus of WCM. An organisation that can’t deliver quality and service at high levels of performance will lose customers faster than they can win. According to Grieco (1996):

“We find that for every customer who communicates the issues to us, there are 50 who remain quiet and find another source of supply. The ‘wronged’ customer will tell 50 other people about their problems with your company and its performance level. This bad publicity is compounded ...”

Therefore it is very important for the company to be able to provide good quality and service in order to gain customer confidence and at the same time to increase the

customer loyalty. What the customers need are better quality, quicker response and greater flexibility. The road to world-class performance requires a multipronged approach – delighting customers with better quality, competitive pricing, and a wealth of new product offerings, while not losing focus on the international improvements to be gained by operating leanly and becoming more flexible (Industryweek, 2000).

Authors such as Giffi, Roth and Seal (1990) aver customer and quality aspects as two of the focal points of WCM. However this view must be supported by a unification of manufacturing strategy and capabilities, management approaches, organisational factors, human assets, technology and performance measurement. The idea was sustained by Defillipo (1997) who also emphasised the customer as the primary focus of WCM. He defines WCM as a method of organising people and equipment to maximise customer satisfaction while minimising the resources required. Heim and Compton (1992) claimed that a world class manufacturer must integrate all elements of its manufacturing system to satisfy the needs and wants of its customers. It must exterminate organisational barriers to permit improved communication and to provide high quality products and services. World-class manufacturers emphasise that everyone within the organisation must know their customers and must seek to satisfy the needs and wants of customers and other stakeholders. According to Hanson (1992), a manufacturer must adopt a world-view in providing the utility that solves the customer problems. He argues that developing this world-view begins by the recognition that even though all the company's internal organisations – sales, marketing, engineering, and manufacturing– operate interdependently, they have a common focus and commitment to delivering customer satisfaction.

3.1.3. Lean Production

Further explanations used to define WCM come under the Lean Production concept. The Department of Trade and Industry (DTI) claimed that Lean Production gives the factory less of everything – less human effort in the factory, less manufacturing space, less investment in tools, less engineering hours to develop new products, and in less time. It appears to cut set up times from hours to minutes, to prevent the need for expensive systems to track materials, and to arrange manufacturing into cells which can achieve a natural rather than an imposed momentum. The DTI (1991) argues that the world class factories will be lean producers if they have the following characteristics:

- Teams of multi-skilled workers;
- Lower volumes in greater variety;
- A commitment to total quality;
- Highly flexible machinery;
- Very high responsiveness.

(Cited in the DTI, M90'S series, 1991)

Author such as Defillipo (1997) asserts that Lean Production is a key to successful WCM. This idea was supported by Markland *et al.* (1998), Oliver, *et al.* (1994) who stress that 'a world class manufacturer is actually a lean manufacturer'. According to Womack *et al.* (1990):

“We’ve become convinced that the principles of Lean Production can be applied equally in every industry across the globe and that the conversion to Lean

Production will have a profound effect on human society – it will truly change the world.”

At its core, lean manufacturing is a means by which the overall business processes are organised so as to deliver products with greater variety and superior quality using less resource and in a shorter time than can be achieved by mass production methods (Jina *et al.* (1997)). Oliver *et al.* (1994) claimed that Lean Production was systematically related to superior productivity and quality. The idea was supported by Anderson Consulting (1995) who used productivity and quality to measure the world-class plant. Authors such as Womack, Jones and Roos (1990) define Lean Production as including practices such as:

- Low inventories, small batches and just-in-time (JIT);
- Quality by defect prevention rather than rectification;
- Engaged in root causes problem solving to eliminate all non-value adding steps, interruptions and variability;
- Production is pulled by the customer and not pushed to suit machine loading, and level scheduling is employed;
- Team- based, flexible and multi-skilled operators;
- Close integration of the whole value stream from the raw material to finished customer, through partnership with suppliers and dealers.

3.1.4. Lists of Criteria

Some authors are more specific in defining WCM. They publish a list of improvements, which companies should meet if they want to achieve WCM status. For example, Professor Colin New of Cranfield School of Management argues that companies aiming to pursue the goals of WCM should be looking at:

- Reducing inventory investment by 50 percent or more;
- Reducing manufacturing lead times by 50 per cent or more;
- Introducing new products at two or three times the present rate and at 50 percent of new product lead times;
- Reducing manufacturing costs by 30 percent or more;
- Reducing overhead /support labour by 50 percent or more;
- Improving quality levels to a ‘parts per million’ defect level.

(Cited in the DTI, M90’S series, 1991)

A further list comes from the Industry Week Census of manufacturers (1997), which provides a checklist of several questions for a firm to rate themselves to determine whether they are achieving WCM or not. Each company was asked to assess their plant’s or company’s progress toward world class under the following categories “no progress”, “some progress”, “significant progress” or “fully achieved”, which reveals who thinks they are world class. The assessments include the following:

- Considerable improvements to first-pass quality yields;
- Scrap/rework costs less than 1% of sales;
- Less than 10 parts per million (ppm) customer reject rate on shipped product;
- Cycle times reduced more than 50% in last five years;

- 100% on-time delivery rate;
- More than 25 annual inventory turns;
- Productivity levels of £250,000 or more per employee;
- Productivity increases of greater than 20% in five years;
- Significant manufacturing cost reduction in the last five years;
- Plant-level return on assets greater than 15%.

3.1.5. Quality Concepts

A further approach is to define WCM under the Quality concept. Quality is associated not only with products and services but also with how people work, how machines are operated and how systems and procedures are handled, and includes all aspects of human behaviour (Imai, 1991). In order to discuss the relevance of quality to the WCM concept, it is first necessary to summarise the quality terms that can be found in the literature. Oakland (1993) summarised the quality term as used by other authors as:

- Fitness for purpose or use – Juran;
- The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs – BS 4778, 1987 (ISO 8402, 1986), Quality Vocabulary: Part 1, International Terms;
- Quality should be aimed at the needs of the customers and the future – Deming;
- The total composite product and service characteristic of marketing, engineering, manufacture and maintenance through which the product and service in use will meet the expectation by the customer’ - Feigenbaum;

- Conformance to requirements – Crosby.

It should be noted that all the terms described above have been considered as ‘best practice’ methods in recent years. Flynn *et al.* (1997) stresses that quality is a key element to attain WCM. Hodgetts *et al.* (1994) define world-class as those who have mastered total quality. It requires careful planning and a philosophy of company-wide quality improvement and its programmes must be permanent, on going practices (Fine (1995)). Yusof and Aspinwall (2000) claim that TQM is a management philosophy that helped many organisations towards achieving world class status. It will help the company create a culture of trust, participation, teamwork, quality-mindedness, zeal for continuous improvement, continuous learning and, ultimately, a working culture that contributes to a firm’s success and existence. Shores (1994) argues that TQM should be thought of as the management system for implementing the process of reengineering the factory through the integration of WCM tools (i.e. JIT, continuous improvement, Quality Control, self-management teams, flexibility of machinery etc.).

Other authors such as Voss and Blackmon (1996) and Morton (1994), place quality in their lists for assessing world-class practices and performances together with other factors such as culture, manufacturing systems, Lean Production and concurrent engineering. Anderson Consulting (1995) uses two criteria, quality and productivity, to assess the world-class company performance. Their measurement of quality is represented by the number of units claimed to be defective by the plants’ customers and is represented in parts per million (ppm), while productivity is represented by the annual output of finished units divided by annual labour hours. Only plants that achieved outstanding results on both these measures qualified as world class. Of the

71 plants surveyed by Anderson Consulting (1995) in 8 countries, 13 plants showed both high quality and high productivity.

More detailed advice to relate the quality approach to the WCM concept came from Deming's philosophy, the so-called Fourteen-Points of management. According to Drummond (1993), Deming's philosophy is founded upon three basic foundations:

- customer orientation;
- continuous improvement; and
- quality is determined by the system.

Deming (1982) claimed that the company's competitiveness depends upon the customer satisfaction. Customer satisfaction is formed through a combination of responsiveness to the customer's views and needs and continuous improvement of products or services. The system is defined as inputs, and the manner in which these are processed (Drummond (1993)). The system must be changed to make sure targets can be met. For instance, anyone can show a reduction in inventory, simply by paying the supplier or some other agent to hold goods. However, the actual reduction requires a redesign of manufacturing systems, ordering procedures, and so forth. The list of Deming's Fourteen-Points of management is as follows:

1. Create constancy of purpose for improvement of product and service;
2. Adopt the new philosophy;
3. Create dependence upon inspection to achieve quality;
4. End the practice of awarding business on the basis of price alone. Instead, minimise total cost by working with a single supplier;

5. Improve constantly, and forever, every process for planning, production and service;
6. Institute training on the job;
7. Adopt and institute leadership;
8. Drive out fear;
9. Breakdown barriers between staff areas;
10. Eliminate slogans, exhortations, and targets for the workforce;
11. Eliminate numerical quotas for the workforce and numerical goals for management;
12. Remove barriers that rob people of pride of workmanship. Eliminate the annual rating or merit system;
13. Institute a vigorous programme of education and self-improvement for everyone;
14. Put everybody in the company to work to accomplish the transformation.

Deming's (1982) claimed that numerical quotas, numerical goals and work standards work against the improvement of quality. They considered only quantity, not quality, and encouraged the production of defective goods to fulfill the quotas. He introduced statistical scales to measure company performance and claimed that employing control charts is "managing for success" because it allows management to see what exists, not some arbitrary figure that it desires (quotas). However, Deming (1982) believed that quality problems are not the responsibility of the shop floor employees. Deming's (1982) argues that 94% of all quality problems are the senior management responsibility. He also claimed that shop floor employees need to be supervised and shouldn't be involved in any managerial level activities. These ideas seem to be different from the more common understanding within the WCM literature. In

general, the WCM concept requires a full involvement of employees in the system (Schonberger (1996), Shores (1994)).

3.1.6. Schonberger's (1996) sixteen principles.

The most comprehensive lists used to define WCM are presented by Schonberger (1986 and 1996). The first version of Schonberger's (1986) WCM lists consisted of 17 general principles. Schonberger's (1996) version has 16 principles, but includes more detail of the improvements/ aims appropriate for each of the principles. Like his first version, Schonberger argues that WCM should begin with the recognition of its customers and employees. He introduces sixteen principles known as "customer-focused-principles" or "principles-based management" for a firm to use to measure their attainment. A firm can rate themselves for each of the 16 principles using a "zero-to-five-point" scale to determine whether they are achieving WCM or not. The areas of measurement include management control, production planning, supply chain management, plant design, human resource management and quality management.

Many of Schonberger's (1996) ideas are similar to Total Quality Management and other WCM literature. For instance Crosby's (1988; 1984) fourteen steps to quality management; Deming's (1982) fourteen points of management and Wakao (1995) all have features in common with Schonberger (1996). However Schonberger's (1996) model extends these frameworks through a step by step improvement scale for each principle. Implicit throughout Schonberger's ideas (1996) is that the content is less important than the process. He provides nearly 20 short case studies to show how the principles can be used to improve various manufacturing processes.

His WCM model offers everything that is discussed by WCM literature including teaming up with customers (Grieco (1996), Shores (1994)), supplier's relationship (Giffi *et al.* (1990), shop floor operations (Anderson Consulting (1995)), human resources (Morton (1994)), quality management (Oakland (1993), Todd (1995)), exploiting capacity (Hendry (1998)) and marketing issues. (Refer to Table 3.1). He argues that WCM management is not "management by the numbers, by financial metrics, by top-down numeric goal setting, ... the new replacement mode, which involves all employees, is managing the processes" (p. 91). He also suggests that value is created as companies adopt customer-focussed principles, such as "teaming up with customers, continual rapid improvement in what customers want, operating at close to the customer's rate of use, and aligning performance measures with what customers want" (Stimpert, 1997)).

For example, as shown in Table 3.1, Schonberger's (1996) principles are also relevant to Oakland's (1993) ideas on quality and Wakao's (1995) ideas on the process improvement. Oakland (1993) claimed that the aim of quality improvement is to meet customer requirements. Wakao (1995) defined process improvement as moving "a process toward an optimal or more stable one with investigations and analysis of all factors of the process, mostly, workers, machines, materials, and methods, which are regarded as the main factors of a cause in quality fluctuation".

Wakao (1995) claimed that quality improvement comprises various practices such as total productive maintenance, cross-functional teams, customer satisfaction, directed teams, statistical process control, automation, benchmarking, housekeeping and

human resources. Those ideas are very much relevant to Schonberger's (1996) sixteen principles.

Table 3.1: *The relevance of other literature to Schonberger's (1996) WCM ideas.*

Schonberger (1996) Category	<i>Other important literature relevant to this topic</i>
Customer focus	Grieco (1996); Defillipo (1997); Lau (1996); Hutchings and Knox (1995); Shores (1994); Oakland (1993); Crosby (1984, 1979); Deming (1982, 1986).
Design	Abraham and Spencer (1998); Hendry (1998); Teague <i>et al.</i> (1997); Jina <i>et al.</i> (1996); Todd (1994); Badore (1992).
Operations	Hendry (1998); Howard <i>et al.</i> (1998); Handfield and Pannesi (1995); Huq <i>et al.</i> (1994); Gargeya <i>et al.</i> (1994); Spencer (1994), Giffi <i>et al.</i> (1990).
Human Resources	Hendry (1998); Morton (1994); Shores (1994); Todd (1994).
Quality and Process Improvement	Yusof <i>et al.</i> (2000); Flynn <i>et al.</i> (1997); Anderson Consulting (1995); Wakao (1995); Todd (1994); Drummond (1993); Oakland (1993); Imai (1991); Giffi <i>et al.</i> (1990); Crosby (1984, 1979); Deming (1982, 1986).
Information for Operations and Control	Hendry (1998); Morton (1994); Shores (1994); Kingsman (1993).
Capacity Issues	Hendry (1998); Gargeya <i>et al.</i> (1994).
Promotion/ Marketing	McClenahan (1999); Hayes <i>et al.</i> (1988); Kingsman <i>et al.</i> (1993); Heim <i>et al.</i> (1992).

“Customer-focussed, workers driven, data based continuous improvement” are the theme of the Schonberger (1996) WCM model. Everyone in the organisation must play his/her part to achieve the principles. Workers are the source of ideas and innovation. Their experience, knowledge, and co-operation have to be tied together to get the best ideas implemented in the organisation. The customer is the heart of the

principles. All improvements made are to serve the customer better. This means that the company must always know how well its outputs are performing, in the eyes of the customer, through measurement and feedback. It is also essential to know what determines the company performance and outputs. This includes continually upgrading operating resources: data, equipment, tools, space, for-sale items, supplies, and people. Schonberger's (1996) sixteen principles are listed as below:

1. Team up with customer; organise by families of customers or products (what customer buys or use);
2. Capture/use customer, competitive best practice information;
3. Dedicate to continual rapid improvement in quality, response time, flexibility and value;
4. Frontline employees involved in change and strategic planning – to achieve a unified purpose;
5. Cut to the few best components, operations and suppliers;
6. Cut flow time and distance, start-up/changeover times;
7. Operate close to customer's rate of use or demand;
8. Continually enhance human resources through cross-training, job and career-path rotation, and improvement in health, safety, and security;
9. Expand the variety of rewards, recognition, pay, and celebration – to match the expanded variety of employee contributions;
10. Continually reduce variation and mishaps;
11. Frontline teams record and own process data at the workplace;
12. Control root causes to cut internal transactions and reporting;
13. Align performance measures with customer wants;
14. Improve present capacity before new equipment and automation;

15. Seek simple, flexible, movable, low cost equipment in multiples;

16. Promote/ market/ sell every improvement.

The above sixteen principles are considered as one of the most detailed lists to define WCM manufacturing. Unlike TQM and other WCM concepts, Schonberger (1996) provides more detailed advice through the “5-steps” scoring system for a company to measure its own performances. As this model was amongst the most comprehensive WCM models in the literature, it was taken as a starting point to develop a MTO model as explained in detail in Chapter 4. It could be argued that Schonberger’s (1996) model is designed as a tool for a consultant and that much of the detail of his model does not have the academic underpinning that is required in good research. However, as shown in Table 3.1 and discussed above, his ideas are related to those in the academic literature and his model is therefore considered to be an acceptable starting point for this research project.

3.2. The Contingent Approach

The universalistic approach to the WCM concept is now being questioned by some authors such as Kochhar and McGarrie (1992), Jina *et al.* (1996), Howard *et al.* (1998). Kochhar *et al.* (1992) investigated the impact made by individual manufacturing characteristics on the choice and implementation of different manufacturing control systems. They used MRPII as an exemplar of manufacturing control systems and discovered that different kinds of manufacturing company require different types of control system, or different individual modules of an overall system such as MRPII. Based on seven case studies, they proved that the choice of

manufacturing control systems take account of not only internal considerations such as the products, the manufacturing processes, the workforce and the systems in place, but also the external considerations such as the demand from the market. In other words the choice of control system was indeed contingent upon the type and characteristics of the company. Kochhar and Suri (1992) introduced a process known as “knowledge-based gap analysis” which may be used to help with the implementation of different kinds of Master Production Scheduling systems. They concluded that “by auditing the existing systems and procedures in an organisation, and comparing them with the necessary and/or desirable prerequisites, it is possible to identify the major problems which must be addressed by the management in order to achieve an effective implementation”.

Authors such as Jina, Bhattacharya and Walton (1996), explain that lean manufacturing procedures need to be adapted if they are to be applied to companies which they describe as ‘high variety low volume’ (HVLV) manufacturers. They concluded their research by examining some of the developments in two very different types of HVLV organisation. One was a very low volume manufacturer in the aerospace industry, and the other was a manufacturer of a low to average volume of specialist machinery. Both organisations have a “high variety, make to order” business strategy. The research shows that the emphasis of the lean manufacturing elements employed depends on the specific circumstances of the HVLV organisation. They claimed that “the lean formula is applicable directly only to a small proportion of manufacturers: most companies must carefully judge which lean practices they can use immediately and which need to be adapted to meet their special circumstances”.

The ideas that the choice of control system was contingent upon the characteristics of the company were also sustained by authors such as Howard *et al.* (1998), Sousa & Voss (1999). For example, Howard *et al.* (1998) claimed that there are many approaches to manufacturing planning and control which are used (MRP, MRPII, OPT, JIT, etc.); all have particular strengths in particular areas, and no one single method is appropriate for every company. Howard *et al.* (1998) have developed a model which is claimed to be capable of providing independent objective advice to companies for defining a functional specification for appropriate planning and control systems.

Authors such as Sousa & Voss (1999) examine whether there is a link between a plant manufacturing strategy and the pattern of use of best practices. Their research was based on three companies, each of a dissimilar company type as characterised by their choice of manufacturing strategy, that were all judged to be mature in their use of best practice paradigms. They used quality management as an exemplar of best practice, and found that the choice of procedure was indeed contingent upon the type of company.

Shores (1994) provides a checklist of nine questions for a firm to rate itself whether it is achieving WCM or not. Shores (1994) claimed that there is no single approach that will work for everyone. Every business and environment are different, and adjustments need to be made to suit each case. However, the guidance he provides is generic, only providing one list which firms must adapt for themselves.

Hendry (1998) presents a more thorough review of the literature, illustrating areas in which the general advice on becoming world class does not apply to MTO companies in particular. As stated in chapter 1, the paper claims that a universalistic approach to WCM practice is not beneficial for firms in the MTO sector. According to Hendry (1998), most of the WCM advice is general and concentrates on methods of operating that have come to be considered as “best practice” in recent years. It concludes by making a preliminary attempt to identify a better set of guidelines for this sector. The guidelines are categorised into “small impact” and “big impact” changes. “Big impact” changes include: improve visibility, exploit capacity, set up time reduction, improve information flow and scheduling, and implementing a performance measurement system. “Small impact” changes related to the design issues, commonality of parts (common forgings), improve relations with suppliers and customers. However, this advice is not detailed and the paper concludes that a more refined working model is needed for the MTO sector. Further research is needed to develop and justify the proposed guidelines.

3.3. Conclusion

It can therefore be concluded that the majority of research into WCM has taken a universalistic approach, and has developed general models covering all aspects of manufacturing management. Whilst there has been some research that suggests that appropriate best practice procedures are contingent upon company type, none of this research has tried to develop a detailed WCM model for the MTO sector. Amongst the universalistic approaches, one of the most comprehensive models is that presented by Schonberger (1996). This model draws together many of the ideas presented by

other authors in the WCM field, and other important areas such as TQM. Therefore, in developing a model for the MTO sector, the next step was to look at Schonberger's (1996) model in more detail.

CHAPTER 4

THE RELEVANCE OF SCHONBERGER'S MODEL TO MTO COMPANIES

The discussion of the different approaches to WCM in chapter 3 concluded that Schonberger's approach, as described in his book of 1996, would be a good starting point for developing a new model for determining WCM in relation to MTO companies. This chapter reviews Schonberger's model in more detail. Firstly, the underlying concepts and the relevance of the philosophy to the MTO sector are discussed. Then the detailed stages of each of the sixteen principles in Schonberger's (1996) model are considered to determine their level of appropriateness to MTO. In addition, ideas in the MTO literature that are not included in Schonberger's (1996) model will also be identified.

4.1. The relevance of the underlying concepts

During the past few years, enormous changes have taken place in the concept of management culture. There have been changes from management by edict to management by procedures to management by policies. Schonberger (1996) argues that the next change is going to be to management by principle. Schonberger's (1996)

definitions of the various concepts of management culture, from edicts to principles are summarised in Table 4.1 and described in detail below the table:

Table 4.1: *Toward Twenty-first Century Management of the Manufacturing Enterprise*

<p>FROM EDICTS TO PRINCIPLES <i>Success in the next decade requires a higher order of management. Schonberger's assessment of various management modes:</i></p>
<p>MANAGEMENT BY EDICT – <i>Inconsistent, wasteful of talent, and out of touch.</i></p>
<p>MANAGEMENT BY PROCEDURES – <i>More consistent and quicker, but wasteful of talent: filled with gaps that force-fit poor solutions, adversely affecting customers.</i></p>
<p>MANAGEMENT BY POLICIES – <i>Reflects high-level wisdom, but limits broad empowerment and organisational learning.</i></p>
<p>MANAGEMENT BY PRINCIPLES – <i>Customer-focussed, employee-driven, data-based; broadly effective, robust, enduring.</i></p>

Source: Schonberger (1996)

The first mode of management culture is known as *management by edict* where workers take orders from managers, supervisors or functional experts. Schonberger claimed that this is the worst mode of management, because it is “arbitrary, wasteful of the experience and talent of the workforce, and lacking in a customer outlook”.

The second mode of management culture is *standard operating procedures (SOPs)*. Schonberger (1996) claimed that SOPs are a more systematic mode of management culture which can “remove capriciousness and allow quicker decisions: just find the best way, authorise and record it, teach it, and expect it to be followed”. However this is also wasteful of individual talents. Procedures-based management has gaps, often

there are “no procedures to cover certain situations- and it tends to force a procedure to fit where it doesn’t belong” (Schonberger (1996)).

The third is *management by policy*. Schonberger argued that policy based management “allows latitude within bounds” which can partially correct the above problems. However, still, the policies fail to incorporate a wide range of knowledge and experience. The employees are more empowered, but “policies are too often misguided and inward looking. Worst of all, policies restrict speedy organisational learning, especially as it relates to customer needs” (Schonberger (1996)).

The fourth mode of management culture is *management by principles*. Schonberger (1996) claimed that by today’s standards, a good manufacturing firm must do the following:

- Serve the best interest of customers;
- Fully involve all employees;
- Ensure that all actions about processes, customers, competitors and best practice are data (fact)-based.

He avers that the best way to manage and operate a company is by adhering to a customer-focussed orientation. Being employee driven means that each employee becomes a manager of their own processes, taking responsibility for developing their knowledge and skills, and has the opportunities for sharing their knowledge and skills with other employees. Data (fact) based management refers to having “systematic

data about processes, customers, competitors, and best practices” to continuously improve the company performance and practices.

However, Schonberger (1996) argues that edicts, procedures and policies should still exist in management culture.

“I am not suggesting there be no edicts, no procedures, and no policies. Of course there should. At times, if no one takes charge and gives a few orders, opportunity slips by. An organisation with no procedures will appear random and out of control to the most important target of all: the customer. And policies, if they are fairly stable, can build organisational culture, which helps anchor employees, providers, and customers.” (1996:21)

However, management by principles goes a step further. According to CEO Lou Gerstner (quoted by Schonberger (1996)), management by principles mean when a situation arises, there is no need to go for the manual. Instead employees know in their heart and head what to do.

Implicit throughout Schonberger’s idea is that the content is less important than the process. What companies do is less important than how they do it. Management attention must be focused on processes such as how products are designed, how the workforce is trained, how data are used to isolate mishap, and how suppliers and customers are treated.

The idea that the content is less important than the process could be argued to apply to all company types. Similarly, the main elements of the underlying concepts, customer focus, employee driven, and data (fact) based management, are very general and can be considered relevant to all manufacturing environments. Some readers may be skeptical about the underlying idea of ‘knowing in their heart and head what to do’, but this is also not a company specific suggestion. However, when companies try to use the framework it is really the detail of the principles themselves that will be applied and not the underlying concepts. Therefore, although the ideology may be applicable to company type, it is necessary to look at the detail of the principles to determine their relevance to the MTO sector.

Of course, some readers may disagree with the ideology or feel that it is not particularly meaningful. Indeed, much of it is written in consultancy style with sweeping statements that are not academically justified. In the new WCM model proposed in Chapter 5, this ideology is not of particular importance. Instead, it is aspects of the detailed principles that are used in devising the new model. Therefore, for this research, it is the detailed principles that need to be studied in further detail rather than the underlying ideology of Schonberger’s (1996) work.

4.2. The Detailed Steps of the Sixteen Principles

As discussed in chapter 3, most of Schonberger’s (1996) ideas are not new. However, the evaluation framework he offers for pulling the ideas together and applying it to the company is new, and this evaluation guide can assist companies to determine the next stages needed to improve their operations, practice and performance. This framework

has sixteen principles, each one has a five-point scale which uses level one (one point) for the most primitive and level five (five points) for the world's most efficient. Many companies have made tremendous efforts in certain categories; but no company is yet known to have achieved the top score in all categories. A company that has just begun to adopt world class practice probably will get close to one point. Those who have been implementing world class practices for a few years may score well on a few principles but not on the others. In some cases, a company may not take the easiest path. Therefore on a certain principle a company may score a point at the second step without having scored at the first step.

In order to discuss the relevance of the sixteen principles or “customer-focussed principles” to the MTO sector, it is first necessary to list each principle step-by-step. The principles together with the associated criteria for levels 1 to 5 are shown in Table 4.2 below:

Table 4.2: The detailed five steps for each of Schonberger's (1996) Sixteen Principles

<i>General</i>
<p><i>1. Team-up with customers; organise by customer/ product family.</i></p> <ol style="list-style-type: none"> 1. Cross-functional project teams 2. Customer/client representatives on project teams 3. Focussed work-flow teams (cells) for key product/ customer families. 4. Entire enterprise reengineering by customer/ product family 5. Customer/client representatives for each focussed unit. <p><i>2. Capture/use customer, competitive best-practice information</i></p> <ol style="list-style-type: none"> 1. Gather customer-satisfaction data and competitive samples and metrics 2. Gather customer-needs and best practice data, and non-competitive metrics 3. Systematic customer surveys: full scale bench marking for key process 4. All associates involved in customer/competitive best practice assessment 5. Broad implementation of better-than-best practice for customer service.

Table 4.2: *Continued*

3. Continual rapid improvement in what all customers want

1. 50% improvement in quality (Q), speed (S), or flexibility (F) in a key process
2. 80% improvement in Q, S, or F, in a key process
3. 90% improvement in Q, S, or F in most key processes.
4. 95% improvement in Q, S, or F and value (V) in most key processes.
5. Sustained yearly QSFV improvement rates of 50% or more in all key processes.

4. Frontliners involved in change and strategic planning

1. Frontline associates assist in planning changes in own jobs
2. Frontline teams assist in planning and implementing changes in own processes
3. Frontline teams continuously plan and implement process improvements
4. Frontline teams plan /implement cross-functionally with other teams
5. Frontline teams help develop strategies and set numeric goals, self-monitored

Design

5. Cut to the few best components, operations and suppliers

1. 50% fewer parts/service operations or suppliers for a key product or service
2. 50% fewer parts/operations and suppliers for all key items
3. Average reductions of 50% for all items
4. Average reductions of 80% for all products and services
5. Average reductions of 90% for all products and services.

Operations

6. Cut flow time and distance, start-up/changeover times

1. Train associates in readiness, set-up/changeover, queue limitation
2. In key processes associates cut get ready/set-up, flow time and distance 50%
3. Associates achieve 50% average reductions across all processes
4. Experts help achieve 80% average reduction
5. Cross-functional teams achieve 90% average reductions.

7. Operate close to customers' rate of use or demand

1. Final process synchronised to rate of use/demand for a key product or service
2. Final process synchronised to rate of use/demand – all key products or services
3. 50% of flow path synchronised to rate of use/demand for key items
4. 80% of flow path synchronised to rate of use/demand for key items
5. Entire flow path synchronised to rate of use or demand.

Table 4.2: *Continued*

Human Resources

8. Continually train everybody for their new roles

1. Key managers and teams receive overview training on process improvement
2. 40 hours of just-in-time (train-do, train-do etc.) training for all associates
3. 25% of associates certified as multiskilled
4. 50% of associates certified as multiskilled: most also certified trainers
5. 80% certified as multiskilled: most also certified trainers

9. Expand variety of rewards, recognition and pay

1. Systematic, public recognition/celebration of achievements
2. Variety of low-cost/no-cost awards to both teams and individuals
3. Investing in employees via training, cross training, cross careering.
4. Pay for skills/knowledge: team/unit bonuses (no piecework)
5. Profit/gain sharing: stock/stock options

Quality and Process Improvement

10. Continually reduce variation and mishaps.

1. Training in and use of “7 basic tools” of statistical process control (SPC).
2. Capability analysis for key processes: rework defects and lateness cut 50%
3. 1.0 capability (Cpk)* for key processes: rework defects and lateness cut 80%.
4. 1.33 Cpk; defects below 100 parts per million: rework and lateness cut 95%
5. 2.0 Cpk: defects below 10 parts per million: rework and lateness cut 99%

11. Frontline teams record and own process data at workplace.

1. Training in measurement, visual management, problem solving teams.
2. Frontline teams use process analysis, plot trends.
3. 2 or more suggestions per associate per year.
4. 10+ mostly team suggestions/associate, mostly implemented by associates.
5. 25+ mostly team suggestions/associate, mostly implemented by associates.

Information for Operations and Control

12. Control root causes to cut internal transactions and reporting.

1. Training in fail-safing, process simplification, root cause control
2. Work-flow, quality, internal scheduling and labour transactions cut by 25%
3. Internal transactions cut by 50%; 50% of external transactions by fax/EDI
4. Internal transactions cut by 75%; 75% of external transactions by fax/EDI
5. Internal transactions cut by 99%; 99% of external transactions by fax/EDI

Table 4.2: *Continued*

13. Align performance measures with customer wants.

1. Training in universal customer wants: quality, speed, flexibility, value (QSFV)
2. QSFV are dominant metrics in key operations
3. QSFV are dominant metrics in key support department.
4. QSFV are dominant metrics in all processes
5. Second order metrics (e.g. labour productivity, variance) no longer managed

Capacity

14. Improve present capacity before new equipment and automation.

1. Training in total preventive maintenance (TPM) and process simplification
2. Pre-automation (short flow paths, exact placement, housekeeping, etc.)
3. Experts help operators take over their own PM and housekeeping.
4. Experts teach operators to do repairs: downtime cut 50%
5. Operators become technicians: downtime cut 80%

15. Seek simple, flexible, movable, low-cost equipment in multiples.

1. Seek/convert/upgrade marginal equipment to dedicated or high-flex use
2. 10% of equipment 'owned' by focussed teams/cells or is highly flexible/movable
3. 30% of equipment owned by focussed teams/cells or is highly flexible/movable.
4. 60% of equipment owned by focussed teams/cells or is highly flexible/movable.
5. 90% of equipment owned by focussed teams/cells or is highly flexible/movable

Promotion/Marketing

16. Promote/ market/ sell every improvement.

1. General advertising slogans ("Quality Is Job One"; "Team Xerox"; etc.)
2. Positive QSFV trends featured in selling, bids, proposals, ads.
3. Registration; certifications; local awards (ISO-9000, Ford Q1, state award)
4. Global/national awards (e.g., Baldrige); over 90% customer retention
5. Reverse marketing: Out of strength, you choose whom you sell to

The remaining sections of the chapter present the reasons why some of these principles cannot be entirely appropriate to the MTO sector. Firstly, in Section 4.3, some of the assumptions that occur in several principles are described and the reason why these are not entirely appropriate in content and/or emphasis for the MTO sector

are explained. Then in Section 4.4 each of the principles is discussed separately. However rather than going through them purely in numeric order, they are grouped according to their degree of relevance to MTO. Therefore Section 4.4.1 discusses the principles that are applicable to the MTO sector; section 4.4.2 discusses the principles that are applicable to MTO with some minor modifications; section 4.4.3 discusses the principles that need major revisions to fit the MTO sector and section 4.4.4 describes the principles that are not applicable to the MTO sector. The final section of the chapter, section 4.5, concentrates on important omissions from Schonberger's (1996) model. It discusses the important activities and processes in MTO manufacturing that are not addressed in the sixteen principles. This discussion demonstrates the need for a new model for "World Class Manufacturing" in the MTO sector, which is later explained in chapter 5.

4.3. Common assumptions that do not apply to MTO

The main assumptions that are found in this model which are inappropriate for the majority of MTO firms can be categorised as follows:

- ***Product/ customer families are assumed to exist or be easily identifiable;***

Some of the principles clearly refer to product/customer families, making the assumption that there is some common ground that can be established between aspects of the production process. These aspects may include having common material requirements, labour skills, tooling, set up procedures and flow or routing, which lead to similarity in the way the group of products are manufactured. Most

importantly, the processes are quite repetitive, even though the products in the family may differ somewhat.

However, in the MTO sector, the potential to group products is lower because products are always manufactured to customer design and specification. Even where the company specialises in a type of product, the volumes are low even at the component production stage as the product size and material specifications tend to vary enormously. The level of emphasis in this issue is therefore too strong to be applicable to the MTO sector in general.

- ***Workers can be grouped into teams that focus on specific product or customer families;***

Given that there is less potential to form product/family groups, there is obviously also less potential to form workforce teams on this basis. In some small companies, there may also be the problem that there are not a sufficient number of employees to be worth grouping them into teams.

However, working in a team environment to achieve specific objectives may be possible in the MTO sector. For example, teams could be established around some of the production processes such as drilling, painting, finishing and so on. In some cases, it may also be possible to form a team on a short-term basis for a specific project. Such teams could address issues such as better housekeeping, improving productivity and improving product quality.

Therefore, although some form of team working may be appropriate, any emphasis on product/customer focus teams needs to be removed.

- ***The customers are assumed to be fairly constant over time;***

Another assumption is that the customers are fairly constant over time. As described in Chapter 1, this idea may be attainable for RBC but not for VMC. Even for RBC, the company may not be able to establish a very long-term relationship with its customer compared to companies in the MTS sector. Thus RBC companies will still have relatively high variety and low volumes and cannot make as many efficiency gains as MTS companies with a fairly constant customer, and hence product, base.

- ***There is a degree of repetition in the work that makes training in “fail-safing”, etc. possible;***

According to Shonberger (1996), “fail-safing means embedding in the process a device or procedure that will never again allow a non-conformity to occur or to go forward. Then whenever problems surface, their response is to form study teams to isolate root causes and fail-safe the process so the problem is stamped out forever”. This idea of being able to stop problems reoccurring assumes a degree of repetition in the production process. If the same product is being made on a repeat basis, it is much easier to identify problems and prevent them from occurring again. Often the most significant feature of the MTO manufacturing especially VMCs, is that they are producing a wide variety of new products in low volume. Since the company keeps producing new products, they will encounter many different kinds of problems during each process. This makes it much more difficult to anticipate and stamp out problems

on future orders. However there is a degree of repetition of using the machine that makes some training in “fail-safing” the machines possible in the MTO sector, although it must be concluded that there is less potential for this type of company to learn from its past mistakes.

- ***This degree of repetition also enables the use of a limited number of suppliers, components etc.;***

Given the lack of standard products in the MTO company, it is usually more difficult to reduce the number of suppliers. Jina *et al.* (1996) suggest that the MTO company can make changes in this area by aiming at “common forging”. However, in many cases, even an attempt for parts commonality or common forging may be extremely difficult given that the customer has such a heavy influence on the design of the products.

- ***Zero-defects are attainable due to repeat production;***

Failure to do things right causes many disruptions of material flow through an operation. According to Markland *et al.* (1998), jobs that must be redone create additional costs through scrap and rework that are usually not recoverable. This is true for all kinds of manufacturing environments including MTO companies. However the degree to which it is possible to improve quality and reduce waste will vary from one company to company. For example, cutting rework defects and lateness to zero or 1.5 C_{pk} (process capability index) which equates to 3 parts defects per million (Maleyeff (1997)), may be difficult in some MTO companies because of the high variety of new products being made. This issue is related to the issue of fail-safing discussed above –

again it is the difficulty of learning from past mistakes given that the order book varies constantly that makes this assumption less valid for the MTO sector.

- ***A simplified shop floor layout can be achieved such as the cellular layout;***

The term cellular layout is not explicitly used in the principles but underlies some of the steps. For example in principle 6 a layout of this type is essential if the company is to reduce the flow times, distances and set-up/changeover times by the 90% required to gain the highest score. In cases such as this principle, it can be argued that the MTO firm should also try to reduce flow times, distances and set-ups. However, the methods open to them, that enable the required degree of flexibility to be sustained, are unlikely to lead to such high reductions (Hendry (1998), Jina *et al.* (1996)). Indeed shop floor simplification using a cellular layout assumes that cells of product families can be found, which as discussed earlier, is difficult given the high variety of products in most MTO firms.

- ***Implementing JIT control systems and principles;***

The benefit of implementing just-in-time (JIT) principles in a repetitive manufacturing environment is well known (Morton (1994)). JIT is designed to achieve high volume low variety production using minimal inventories of raw material, work in process, and finished goods. However, the environmental conditions in MTO typically require a different kind of control system to manage its operation. Krajewski *et al.* (1996) claim that the success of a production system depends on the manufacturing environment, not the system. According to Gargeya *et al.* (1994):

“Job shops have two unique characteristics that may constrain their abilities to accept and implement the JIT philosophy. Small job shops (relative to large manufacturing firms) have a broad product range and meagre operating revenues. As a result, they lack the ability to process jobs in a continuous or repetitive manner and are severely constrained in resources – such as capital, human power, and managerial expertise.”

Again it is the issue of lack of repetition that makes this assumption regarding the use of JIT less appropriate to MTO. In a JIT production system, jobs are pulled through the system, that is they are authorised whenever they are needed (Hurley *et al.* (1999), Gargeya *et al.* (1994)). The kanban control system is used to limit the amount of WIP between production stages. For this to work, a standard set of components are needed, which are manufactured through the same production stages on a repeat basis. This is not the case in a MTO environment in which every job may have a distinctly different routing. Furthermore, the variability in processing times and the inability to allocate tasks to various production stages equally will create imbalance on the shop floor and the kanban system is not designed to deal with such imbalances (Huq and Huq (1999)). For these reasons, “it is recommended that companies should not attempt to implement JIT in job a shop. Instead they should look into the option of implementing better shop control procedures” (Huq and Huq (1999)).

Some authors such as Handfield and Pannesi (1995), Spencer (1994), attempted to apply JIT methods in MTO manufacturing. However their work clearly addresses the standardised customisation MTO processes, which as discussed in Chapter 1, are

defined as MTO4 and MTO5 by Amaro *et al.* (1999). These companies only produce products based on an existing design. The reason for doing this after receipt of a customer order is that this is cheaper for expensive products for which there is an irregular, low demand. Thus this application of JIT does not apply to the type of MTO company addressed by this thesis.

Having said that a JIT control system is unlikely to work, the MTO company may be able to implement some aspects of the JIT philosophy. These aspects may include prevention of crucial idle resources, reducing inventory and queues, improving workers' understanding of quality issues and cutting rework. These are valid aims in all manufacturing firms and so it is important to ensure training to make employees aware of these issues.

In conclusion, it can be seen that JIT control systems are concerned with high volumes and low variety repetitive production environments. They may also be appropriate for medium volume/variety or fit with the ideas on mass customisation (Spira *et al.* (1993)). But as shown in the discussion of the principles in detail in the following sections, when it comes to the low volume and high variety end of the spectrum as experienced by MTO companies, the ideas that result from these assumptions can often be less workable.

4.4. The Relevance of the Sixteen Principles to MTO sector

4.4.1 Principles that are applicable to MTO

- ***Principle 7: Operate close to customers' rate of use or demand.***

This principle is so fundamental to MTO that it actually describes this type of firm. As the MTO firm only produces items that have been ordered by the customer for agreed delivery dates, this ideal is already achieved and therefore it seems out of place as an issue to strive for in achieving WCM practice. Therefore, although it is relevant to both MTS and MTO companies, it was decided that it should not be a target in the new MTO model.

- ***Principle 14: Improve present capacity before new equipment and automation.***

The main issue that underlies this principle is Total Preventive Maintenance (TPM). This issue is universally applicable to all kind of manufacturers regardless of their type of manufacturing operations because whatever type of machinery is used, proper preventive maintenance is a cost-effective way to make the machinery work better and last longer. According to Gargeya *et al.* (1994), with a TPM plan the maintenance team works proactively to eliminate breakdowns on the production line. TPM incorporates the use of autonomous maintenance by operators, and the use of small group activities to improve equipment reliability, maintainability, and productivity (Chen, (1997)). Through TPM, the knowledge of the employee is utilised to improve equipment and process design to lower both maintenance and operating cost.

In MTO companies, TPM skills for individual machines could be developed informally, through informal training and from years of personnel operating experience. This is because most MTO companies are skill-based, that is they have highly skilled and flexible workers. With this kind of skill level, preventive maintenance can be easily implemented, as workers are already familiar with the machines and able to operate the machines without much supervision.

However, due to the advance in technology, many firms prefer to employ Computerised Numerical Control machines (CNC) (Garsombke *et al.* (1989); Steiner and Solef (1988); Liberatore and Titus (1986)). Therefore MTO firms also need more formal training to allow production personnel to perform some simple repairs and maintenance for CNC machines. Training may also include topics such as vibration readings, control chart analysis, root cause analysis, changing and tightening belts, replacing oil seals and so on. However, even for this level of training, the high skill levels of the MTO sector will make this issue as relevant to them as to other sectors of industry. In fact, it could be argued that this is easier with higher skill levels and hence higher target levels for cutting downtime should be included in the model than are appropriate for the less skilled industrial sectors.

Shop floor personnel could also implement preventive maintenance through good housekeeping practices as suggested by Schonberger (1996):

“ They list autonomous maintenance schedules, record downtime and minutes of maintenance meetings, monitor maintenance calls, and specify lubrication and inspection points. Operators maintain their own equipment and keep everything

spic-and-span. Everything is labelled, even coat hooks. Painted silhouettes of brooms, mops, and other cleaning implements show where to hang or clamp them on the wall, and all are neatly placed in designated places when not in use.....” (1996: 44)

The ideas behind housekeeping practices as suggested by Schonberger (1996) are to keep the area, as well as the machine, tidy and clean. This level of tidiness can save time in searching for items and prevents breakage of tools, and again is relevant to all industry types.

- ***Principle 16: Promote/ market/ sell every improvement.***

All firms, regardless of size and type, can use promotional tools to help them sell goods and services. These promotional tools may include advertising, sales presentation, personal selling and so on. The aim is to create awareness of the availability of products or services. To achieve this, it is important to have a good understanding of customers’ buying behaviour. This will give information regarding the target audience that can be useful in setting advertising objectives and provides a guide for selecting the appropriate media.

Despite the seemingly obvious importance of this issue, some small firms have failed to increase their turnover because the potential buyers are ignorant of their existence or range of products or services (Baker, (1991)). However, still some of these firms can survive despite taking a relatively passive approach to their market. Their overall approach to their prospective customers involves building upon established purchase

patterns or simply waiting for the potential customers to find them. In favourable conditions it is possible for firms to survive with this type of approach. However, once the situation changes because demand weakens, or a new competitor enters the market this approach becomes very risky.

If a firm decides to make improvements in this issue, then the next step is to decide how to do this. In some cases, media advertising may provide the primary means of reaching their market. However, due to the resource shortages of some small firms, they may be reluctant to explore the media types of promotion (Hart, (1990)). Besides, some types of media advertising are not appropriate for small companies such as in MTO. For example television (TV) advertising is less appropriate for MTO because it broadcasts into peoples home. Most of the audiences are end user customers, rather than the industrial sector which makes up most of the MTO customer base. However, MTO companies can use other kinds of promotional tools including sales presentation, yellow pages phone book, magazines and the internet. Magazines are one of the best places to advertise if they have local or regional issues or if they are devoted to a specific industry. The advantage of the internet is that the customer is in control and can decide which information he/she wants to search for. Whatever the means of advertising, a well-targeted and carefully prepared advertising effort can often easily repay the investment. A good strategy is to make the customer realise that the company has a “forward looking” approach.

However, still many smaller firms struggle to convince larger clients that the company has the ability to meet their needs. Such potential clients may need re assurance about the strength, quality and viability of the product. A well-developed

image built through achieving quality accreditation such as ISO 9000 or global/state awards can build the confidence of larger customers. Such accreditation awards and the needs to promote the companies, which are also included in this principle, are relevant to all industry types.

4.4.2. Principles that are applicable with minor modifications.

- ***Principle 2: Capture/use customer, competitive, best practice information.***

According to Schonberger (1996), this principle aims at three vital sources of external information. The first source of external information is the customers. Some companies have started to build customer databases containing raw information on the customer that can be sorted and enhanced to produce useful information. Records of frequent customers and their transactions are maintained and the companies use this data to find common characteristics among its customers. This data can also be used to find out about the customers' product preferences, their future needs and requirements and so on. The second source is competitive analysis, which includes collecting samples of competitors' products. Clearly, this strategy requires identifying the products and service offered by competitors and how to make the company superior to its competitors. The company can make use of every piece of evidence which can be gathered through secondary sources (i.e. WWW pages, financial statements, etc) or customer survey. The third source of external information is collecting the best practice information. Best practice refers to the external information, which goes beyond the product. In other words, best practice data can be used to find the best way of doing anything, from generating new lines of business to

processing payrolls to negotiating contracts to maintaining buildings (Schonberger (1996)). “Since competitors may not be best at anything, going outside one’s own industry is a must” (Schonberger (1996)).

The above issues are relevant to the MTO sector. Customer needs data can serve as a compass for navigating the company to identify and meet the customer needs, using metrics that are based on validated customer satisfaction drivers. Similarly, the competitive analysis and best practice data can be used as a source of information for the company to improve its operations and be more competitive in the future. However, to gather this kind of information requires a lot of effort because some relevant data is not readily available.

In particular, at the three-point level of this principle, the company is advised to achieve full scale benchmarking. Benchmarking was first developed by the Japanese and pioneered in the western world by Rank Xerox in 1979. It is a tool used by many industries today to gather information that may lead to the increased success of a company (Philips and Appiah-Adu (1998)). The main issues of benchmarking are improving operations, purchasing, services, quality, and reducing the manufacturing lead-time by looking at the methods used by the best companies. Benchmarking can be categorised into competitive benchmarking and non-competitive benchmarking. In competitive benchmarking a firm compares its performance with that of its competitors (Beasley and Cook (1995)). The firm can carry out the competitive benchmarking, measuring itself against industry averages. If the firm falls outside the acceptable range for a particular benchmark, the next step is to identify the causal factors and fix them. In non-competitive benchmarking the firm investigates how

companies in other industries operate. The company can then adopt successful ideas and techniques and customise them to suit its own operations. Clearly, no two companies are the same, yet many procedures and processes are. It is here that benchmarking contributes information.

However some authors, such as Rietz *et al* (1997), claimed that benchmarking is going to be costly for small companies. Rietz *et al* (1997) argue that gathering the required data for comparison is a great burden and hence some competitive companies do not want to take part.

Since benchmarking is going to be costly in MTO SMEs, an alternative idea is to at least ask customers for data on the prices offered by their competitors for particular bids for which they were unsuccessful. Such data will help the company to track reasons for losing past potential orders and may help them to bid more successfully in the future. Full benchmarking can still be beneficial and is needed, but it would be better as a higher level of achievement for MTO. Therefore, to make this principle more appropriate to small MTO, benchmarking issues could be placed later, as a fourth or final step in the new model.

- ***Principle 8: Continually enhance human resources through cross-training, job and career-path rotation, and improvement in health, safety, and security.***

All manufacturing firms, regardless of the type of product made, their size or process, can gain immediate, measurable benefits from exercising and promoting cross-training of their workers within the various departments of the organisation. Cross training employees so that they are multi skilled is perhaps one of the important

elements in attaining better performance in production. By cross training employees to perform several operations, companies can create flexibility and additional advantage in career-path rotation.

However, principle 8 needs redefinition to suit MTO companies because the advice in step 2 embraces the JIT methodology. As described in section 4.3, the JIT control system is mostly suited to repeat business production environments rather than the high variety of the MTO sector.

- ***Principle 9: Expand the variety of rewards, recognition, pay, and celebration.***

Schonberger (1996) stressed that reward and compensation systems are seen to be particularly important in encouraging certain aspects of functional flexibility such as multi-skilling (through pay for knowledge schemes and through performance payments). This principle is appropriate to the MTO sector but step 5 needs redefinition. Step 5 suggests that bonuses or incentives for employees should be paid through company “monetary equivalent” schemes such as stock or stock options and profit sharing. This may be attainable in a larger sized MTO company, but smaller MTO companies are frequently “family owned” and they may refuse to share rewards in this way. Besides the “smallness” of the MTO SME company limits the company’s capability to offer stock options or profit sharing. Therefore step 5 needs redefinition to make it more appropriate to SME’s in the MTO sector.

- ***Principle 12: Control root causes to cut internal transactions and reporting.***

Most of the issues within this principle are relevant to MTO but training in “fail-safing” and process simplification at the one-point level is somewhat less appropriate in MTO manufacturing. As discussed in section 4.3, the company may face some difficulties to “fail-safe” the problems because there is less potential that the company can learn from its past mistakes. Therefore step 1 needs a new definition so that this principle is more appropriate to the MTO sector.

4.4.3. Principles that need major modifications.

- ***Principle 3: Continual rapid improvement in what all customers want (QSFV).***

Organisations that can’t deliver quality and service at high levels of performance will lose customers faster than they can win them. According to Grieco (1996):

“We find that for every customer who communicates the issues to us, there are 50 who remain quiet and find another source of supply. The ‘wronged’ customer will tell 50 other people about their problems with your company and its performance level. This bad publicity is compounded ...” (1996: 10).

Therefore it is very important for the company to be able to gain customer confidence and at the same time inflate the customer loyalty. In this principle, it is argued that the best way to achieve this is to go for across the board improvements in QSFV (Quality, Speed, Flexibility and Value). Some aspects of QSFV could be argued to be easier to

achieve in MTO because quality, flexibility and delivery issues are usually already considered to be important objectives. These issues are important for the MTO companies in order to be able to compete in the MTO environment. The quality must be good, the employees and machinery must be flexible to produce high variety low volume products, and the products must be delivered on an agreed scheduled date. However, speed refers to more than just meeting delivery dates. It refers to the ability of the company to provide quick delivery, faster quotes, reducing the distances parts move in the shop floor and reducing set-up process. For example, a job shop company Chicago Metal Rolled Products (Chicago) has successfully shortened the delivery to “two to three” days on a part that takes its competitors “two to three” weeks to produce (Owen (1994)). Faster speed not only permits the shop to produce more economically but also can effectively increase the capacity of the plant to produce more jobs. Whilst this is an important aim for all firms, producers of standard products are likely to achieve higher increases in speed than producers of high variety goods. The MTO customer, wanting a highly customised product, may be a little bit more prepared to wait. On the other hand, high levels of quality and flexibility may be more important for many MTO customers than for customers of MTS producers.

Value, at the four-point level of this principle, could be argued to be a very tough standard for all kinds of manufacturers including MTO. According to Schonberger (1996), when customers search for value, they will search for several attributes (such as quality, speed, flexibility and more) that they can get for their money. “Putting it conversely, value is a new code word associated with removal of non-value-adding wastes of all kinds – a never ending story” (Schonberger (1996)). This term is very

general (although it will mean different things to each industrial sector) and so can be applied to all types of company.

It is therefore concluded that with the exception of value, the QSFV factors may vary in their level of prioritisation according to company type. This principle needs major modification to reflect this, rather than looking for identical levels of improvement in all four factors.

- ***Principle 4: Frontline employees involved in change and strategic planning – to achieve a unified purpose.***

The term frontline involvement means inclusion of the employees on the shop floor. In other words, the frontline associate has the responsibility to make changes by taking action rather than asking permission of management. These actions may lead to rework reductions, non-value-adding (NVA) waste elimination, improved machine maintenance or a sense of responsibility to assign extra work to the machines to make more efficient use of resources. According to Abraham and Spencer (1998), a frontline team or self-directed work team can be defined as a small, independent, self-organised, and self-controlled group in which members flexibly plan, organise, determine and manage their duties and actions, as well as perform many other supportive functions. This team may work without immediate supervision and have been given the authority to hire, promote, or discharge its members.

Given the difficulty of forming teams in MTO companies, as described in section 4.3, it seems that the heavy emphasis on the use of teams within this principle is inappropriate. It may still be important to involve frontline associates in charge and

strategic planning, but teams do not necessarily have to be the mechanism used to achieve this aim.

- ***Principle 5: Cut to the few best components, operations and suppliers.***

Traditionally, purchasing departments have been given the task of negotiating for the lowest prices possible in an effort to reduce cost and increase company profits (Martel (1993)). These traditional associations with suppliers were adversarial. However, today's purchasing calls for an updated strategy with vendors by developing long-term relationships, sharing information, and strategic planning with the company. For example in some industries, suppliers are taking on full responsibility for designing materials, parts, components, assemblies, and even complete systems for automobiles, computers, telecommunications equipment, medical devices and equipment, and many other product (Teague *et al.* (1997)).

However, as described in section 4.3, having fewer suppliers in the MTO environment is less likely to be achievable. This is because aiming at parts commonality is often difficult given that it is the customer rather than the supplier which provides the design. In this situation, the relationships with the suppliers tend to be weaker. This is because ordering parts in small volumes does not encourage suppliers to establish links with their customer. The MTO company may be able to achieve some reduction in the number of suppliers, but the percentage figures will be much lower than required by this principle. Even to earn one point is unlikely to be achievable for MTO firms since a fifty-percent reduction in parts for a key product is very high for a

company who does not have a product line. Therefore this principle needs a major redefinition so that it is achievable by the MTO sector.

- ***Principle 6: Cut flow time and distance, start-up/changeover times.***

The need to reduce flow time, distance and to cut the set up times is common to all manufacturers, but the manner in which this is achieved will vary from one company to another. As described earlier in section 4.3, MTO requires different kinds of control systems to operate. For example, they cannot necessarily change to a cellular layout, which must be essential in this principle if improvements of up to 90% in flow times and distance are to be achieved. Similarly high reductions in set-up/changeover times are much easier to maintain with standard products.

However, the aim of the principle is good and applicable to the MTO sector. MTO companies may be able to achieve some reduction in its flow time/ set up time but the percentage figures will be much lower than required by this principle. Therefore this principle needs major revisions so that it is achievable by MTO sector.

- ***Principle 10: Continually reduce variation and mishaps.***

MTO companies are continually in the process of making new products. Therefore, as discussed in section 4.3, there is less potential for the MTO firm to learn by past mistakes. The main requirements of this principle are to cut rework defects and lateness first to 1.0 C_{pk} and then to 2.0 C_{pk} with rework and lateness cut by 99%, which are very high standards for the high variety MTO environment. The firm may

achieve improvement but not to the level required by the principle (step 1 to step 5). Even to gain two or more points is unlikely to be attainable in MTO. Therefore this principle needs a major revision to make it more appropriate to the MTO sector.

However the first point level of this principle is still relevant to the MTO sector. It requires the management to provide training in measuring the capability of the process using the 7 basic tools of Statistical Process Control (SPC). Training procedures may include methods of using the tools including flowcharts, pareto analysis, histogram, cause and effect analysis etc. These measuring process capability tools are also discussed in principle 13. In addition, changes to the attitudes to quality such as transferring of responsibility from the quality inspector to all workers and increasing the skills of the shop floor workers are still relevant to the MTO to increase the company performance.

- ***Principle 11: Frontline teams record and own process data at the workplace.***

The idea behind this principle is that the firm can make use of the employees' expertise, treating them as a source of ideas rather than just machine operators. If anything, this issue is even more applicable to MTO than MTS because MTO machinists are likely to be more skilled than MTS workers. The skilled machinists are usually familiar with the manufacturing processes and are able to produce their own data for their own processes such as measuring and plotting the results of their work, quality inspection and so on. In other words, shop floor employees are given the responsibility to keep records for their own processes and they must own data

pertaining to those processes. “The supervisors, managers, engineers or technicians have to give up that ownership.” (Schonberger (1996)).

However Schonberger (1996) argues that the best way is to have the majority of the suggestions come from groups or teams of employees in the company. So again, it is not so much the idea behind the principle that is questioned for MTO companies, but rather the emphasis on the team mechanism. The emphasis needs to be altered to make the principle more appropriate for the MTO sector.

- ***Principle 13: Align performance measures with customer wants (QSFV).***

Historically, performance measures have included root cause analysis (e.g. pareto charts to indicate the frequency of nonconformities in product, problem solving), first order results (e.g. defect rate), second order result (e.g. sales growth, productivity) and bottom-line (e.g. profit) (Schonberger (1996)). However, it is now commonly thought that performance measures should be narrower and reflect the company objectives more closely (Kueng (2000)). According to Schonberger, these objectives are the QSFV customer wants as described under principle 3 earlier. This change in approach to performance measures is reflected in this principle, which suggests that management should focus on root-cause analysis and first order results, but not on second order or bottom line metrics. According to Schonberger (1996), “metrics such as productivity, profit and variance are beyond the control of the company people and therefore are less manageable”.

Aligning performance measures with company objectives, which to some extent reflect customer wants, is relevant to all industrial sectors. Thus the removal of second-order metrics at step 5 is important for the MTO sector. However, as described under principle 3, it is less appropriate to say that the MTO customer desires all “QSFV”. Instead, there may be some prioritisation among those features. Therefore this principle needs a redefinition in the first four steps to make it more appropriate to the MTO sector.

- ***Principle 15: Seek simple, flexible, movable, low cost equipment in multiples.***

Having simple, flexible, movable and low cost equipment are the main factors contributing to higher points in this principle. Schonberger argued that the company that chooses fast, complex and large equipment is not taking into account the following customer considerations:

- Customers order many items in the product line at the same time, but the big, fast machine can only make one at a time.
- Each time the behemoth gets set up to run a certain item, many line staff specialties are involved. So it is uneconomical to produce small amounts at about the same rate as customer usage.
- Large-lot production fills stockrooms and warehouses based on demand guesswork-habitually wrong. There usually is plenty of stock of the unpopular items; best sellers are on back order.

- Such costly equipment cannot sit idle. So it runs all the time, requiring an overhead empire to store and manage its frequent excesses, further raising costs that are passed on to customers.
- Getting full usage and output from the equipment tempts scrimping on maintenance, which invites breakdowns and undependable service to customers and, contrarily, less output.
- Single pieces of each kind of equipment can't be dispersed and owned by teams operating multiple customer or product-focussed units.

Cited from Schonberger (1996)

The best is affordable equipment in multiples. “Affordable usually means smaller and easier to set up, maintain, and relocate, which is increasingly important as product life cycles continue to shrink” (Schonberger (1996)).

However, Schonberger (1996) actually defines steps 2 to 5 based on teams that focus on specific product or customer families. As described in section 4.3, grouping employees into teams that focus on specific products is less appropriate. Nevertheless, still the issues of highly flexible/moveable equipment are important in the MTO sector and therefore should remain in the list of WCM issues. For that reason, this principle needs major revision to make it more appropriate to the MTO sector.

4.4.4. Principles that are not applicable to MTO.

- **Principle 1: Team-up with customers; organise by customer/ product family.**

This principle is less relevant to the MTO because it places emphasis on product/customer families. Therefore, principle 1 is dropped because the focussing of workforce teams based on product or customer families as described in section 4.3, is less appropriate in MTO.

4.4.5. Summary.

Table 4.3 gives a summary of the discussion of Schonberger's (1996) sixteen principles in terms of their relevance to the MTO sector. As stated before, this model uses a five-point scale, with the highest level of attainment relating to point 5. In some cases, the conclusion given in Table 4.3 is that a principle is applicable to a given step or point on the scale and then, in the column entitled 'reason', there is an explanation of the material that is not relevant.

Table 4.3: Summary of the relevance of Schonberger's Sixteen Principles to MTO Companies

No	Title	Conclusion	Reason
1	Team up with customer; organise by families of customers or products (what customer buys or use).	Not applicable to the MTO sector.	Unlikely to be possible for MTO to reengineer the company by customer or product focus.
2	Capture/use customer, competitive best practice information	Applicable with minor modifications.	Possible; can be problematic for small firms as it needs a lot of effort to gain higher points.

3	Dedicate to continual rapid improvement in quality, response time, flexibility and value	Need major changes	QSFV may vary in their level of prioritisation according to company type.
4	Frontline employees involved in change and strategic planning – to achieve a unified purpose	Applicable with major modifications.	Too much emphasis on the teams mechanism.
5	Cut to the few best components, operations and suppliers	Need major changes	The company is unlikely to have a product line. The inherent flexibility often requires a wider range of components and suppliers, though the use of common forgings may be feasible.
6	Cut flow time and distance, start-up/changeover times	Partially appropriate to step 1. Need major changes.	Most appropriate for repetitive manufacturing system, that can use a cellular layout.
7	Operate close to customer's rate of use or demand	Applicable (This is a characteristics of MTO).	Due to the nature of MTO, synchronise to the rate of demand is always appropriate.
8	Continually enhance human resources through cross-training, job and career-path rotation, and improvement in health, safety, and security	Applicable for step 1,3, 4 and 5. Not applicable for step 2.	All manufacturing firms regardless of type and size can gain benefits from exercising this principle. However step 2 assumes the use of JIT procedures, which may not be appropriate. Also multi-skilling is more essential for MTO firms.
9	Expand the variety of rewards, recognition, pay, and celebration – to match the expanded variety of employee contributions	Applicable to large MTO's but not to smaller one. Needs minor changes.	All manufacturing firms regardless of type and size can gain benefits from exercising this principle but the ideas on stock options/profit sharing is less appropriate.
10	Continually reduce variation and mishaps	Appropriate to step 1 only. Needs major changes	There is less potential for the company to learn by its mistakes since it is continually in the process of making new products.
11	Frontline teams record and own process data at the workplace	Applicable with major modifications	Too much emphasis on the product teams mechanism.
12	Control root causes to cut internal transactions and reporting	Applicable with minor modifications	Possible for all manufacturers, though root causes may change and be less easy to control as product variety is so high.
13	Align performance measures with customer wants	Needs major modification.	The main customer wants vary according to company type to some extent.

14	Improve present capacity before new equipment and automation	Applicable	Possible for all manufacturers.
15	Seek simple, flexible, movable, low cost equipment in multiples	Appropriate to step 1 only. Needs major modification.	MTO does not have product focussed teams, as is assumed by the detailed scoring system in this principle.
16	Promote/ market/ sell every improvement	Applicable	All manufacturing firms regardless of type and size can gain benefits from exercising this principle

4.5. Issues relevant to MTO not included in Schonberger(1996).

An important conclusion that can be drawn from the discussion of Schonberger's (1996) sixteen principles is that with proper modification, some his ideas can suit the MTO sector. However there are still many areas that need to be addressed for the MTO sector which are not included in Schonberger's (1996) model. These areas can be listed under six distinct headings as described below.

- ***The divide between the marketing and production functions;***

The first issue, the need for integration of the production and marketing functions when bidding for customer orders has been recognised by many researchers including Henderson (2001), Brown (2000), Hill (1993), Kingsman *et al.* (1993), Lee and Kim (1993) and Hendry *et al.*(1993). A major problem in MTO is the divide between sales/ marketing and production. The dilemma is usually caused by dissimilar objectives. The production function is usually evaluated by the costs they incur. Hence, they are more concerned with costs rather than profits. The marketing division aspires to increase their market share and are often more interested in total sales than profits. If

this conflict is to be resolved, it will be necessary for the marketing department to be aware of the capabilities of manufacturing and to take full advantage of them (Hendry and Kingsman, (1989)). Likewise, the production function should be conscious of the importance of particular customers and be prepared to adjust its capability in specific events, where feasible. Where co-operation of this type does not exist, orders are often delivered later than promised and/or are produced at a loss rather than generating a profit. The world class MTO firm should have systems in place that ensure that realistic yet competitive prices and delivery dates are quoted for incoming enquiries, and should be able to manage its order book in such a way as to ensure future business by maintaining a good reputation for reliability.

- ***The nature of the design process, which needs to allow the quick production of new manufacturing specifications for tenders;***

The second issue, relating to the distinct nature of the design process, has been identified in empirical research carried out by Amaro *et al.* (1999). Amaro *et al.*(1999) shows that MTO companies should aim to have an efficient and versatile means of developing drawings, designs and specifications for new products. This often entails having a database of products previously produced that can be modified as required. The database should also contain information on parts and forgings that are already used, so that new items are not introduced unnecessarily. As has been described in Section 4.3, it is in the latter area of common forgings that MTO companies often gain the most, as the parts themselves often have to be made in-house to customer specification.

- ***The nature of any “repeat” business which can be obtained and the consequent relationships with customers;***

The third issue regarding “repeat business” has been identified in Amaro *et al.*(1999). As explained in chapter 1, some types of MTO producers referred to as RBCs usually try to gain repeat business by developing long term relationships with their customers. Where companies are able to gain some repeat business, efficiencies are gained and this enables them to reduce costs and therefore become more competitive on other orders for which they are bidding. Thus a characteristic of a world class company would be to have achieved some success in obtaining both repeat business and the consequent efficiency gains.

- ***Flexibility of process that often requires a job shop layout;***

The flexibility of process referred to in this fourth issue relates to the need for many MTO companies to make a strategic decision to retain a functional layout rather than changing to cellular. As discussed in Hendry (1998), some authors, such as Ward (1994) and Jina *et al.* (1996), suggest that this may be true for a one-of-a-kind or small batch producers and for companies that manufacture a large proportion of ‘strangers’. The option of changing to a cellular layout may still be possible if product families can be identified (Ferrás, 1994) and should always be considered, however it cannot be assumed that this is an essential characteristic for a world class MTO company. Instead, more efficient methods of operating under a job shop setting need to be investigated as discussed under the next issue.

- *Methods of controlling the workloads/queues in a job shop environment;*

Several alternative methods of controlling the workload/queues in a job shop, as suggested by this fifth issue, have been discussed in the literature. Firstly, there is the concept of order release – that is determining when to release a job from the planning stage to production, which has been discussed by authors such as Melynk & Ragatz (1989); Philipoom *et al.* (1993); Lingayat *et al.* (1995) and Bergamaschi *et al.* (1996). This concept has been incorporated into a body of research, which has been given the label of workload control by authors in the field including Land & Gaalman (1996, 1998) and Zapfel & Missbauer (1993). The aim is to control the total amount of work on the shop floor in such a way that firms can more consistently meet promised delivery dates, an important objective for MTO firms. To implement a full system of this type would require the implementation of computer software that is not yet readily available on the software market and hence ‘in-house’ systems would need to be developed. Alternatively, it is possible to consider the use of finite or infinite capacity planning techniques, along with some ideas from the more traditional, larger body of research into alternative job shop scheduling or dispatching rules, for example see Schartner and Pruett (1991). Material of this type is readily available in software packages such as the FOURMAN software described in a product overview by the producers MAPS (1995). Lastly, case study evidence presented in Hendry (1998) suggests that simply improving the overall tidiness of the shop can have a big impact even in the job shop environment. This could involve simple storage systems for tooling and WIP, that can greatly reduce the amount of non-value added time used in the more typical untidy job shop.

The choice of method to implement cannot be easily prescribed as has been discussed by authors such as Porter & Little (1996). It depends as much on the availability of appropriate software as on the size/complexity of the business, which will dictate both the cash flow available for software and whether sophisticated software or simpler spreadsheet methods can be implemented. In conclusion, it is argued that the world class MTO company should have:

- implemented appropriate scheduling systems, making use of computer facilities if appropriate;
- should have seen big reductions in WIP and
- should be able to offer short manufacturing lead times and a reliable service to the customer by a reduction in non value-added time.

- ***Pride of craftsmanship among the workforce.***

The sixth issue relates to one of the most basic distinctions between MTO and MTS, the inherent flexibility of their workforce. The employment of well-trained, highly skilled employees has been a traditional strength, often described as craftsmanship, in the MTO sector (Hendry (1998)). However, MTO workers often still need to attain higher standards in several areas including motivation, enthusiasm, housekeeping, quality assurance, preventive maintenance, and machine repair. The world class MTO firm will achieve even higher levels of flexibility and worker skill than can be expected in the MTS firm and therefore the world class model needs to reflect this.

4.6. Conclusion

Some of the common assumptions found in Schonberger's (1996) model and other related literature are not appropriate to MTO manufacturing. For instance the emphasis on a product family focus, cellular layout, JIT control systems and so on are less relevant to the MTO sector. Therefore a new model needs to be developed to exclude or reduce the emphasis of those inappropriate assumptions and to include the issues relevant to MTO that are missing from much of the WCM literature. The latter include issues on integration between the marketing and production functions, methods of controlling the workloads, the nature of any repeat business and so on. These issues have been taken into account in developing a new model as described in chapter 5.

CHAPTER 5

INITIAL IDEAS FOR A NEW WCM MODEL, LABELLED “SHEN”, FOR THE MTO SECTOR

It was decided that the new WCM model for the MTO sector should have a similar level of depth/ comprehensiveness to that of Schonberger (1996). To that end, the model uses a similar structure to Schonberger (1996) with principles that are broken into a series of steps. However there are 14 principles rather than 16 and many of them are significantly different to those of Schonberger (1996) in detail as well as in the titles. It is worth noting that as no acronym came naturally from a description of the model, it was decided to use the names of the researchers to label the new model. This label “SHEN”, is derived using part of my name and that of my supervisor: *SH*aladdin, *HEN*dry. This chapter describes how the initial version of the model was devised using the deductive approach, before any data collection. Section 5.1 gives an overview of the initial SHEN model, showing how the principles can be categorised and indicating where they relate to Schonberger’s (1996) material or other parts of the literature. Section 5.2 describes the use of steps within each principle indicating the number of steps used and the reasoning behind that choice. Finally section 5.3 describes each of the initial 14 SHEN principles in greater detail.

5.1. Overview of SHEN

The new model groups its principles into 4 categories, each containing several inter-related principles. The categories are intended to assist the company to track achievement based on related activity. In some cases, the grouping may also help the company to decide how to prioritise the changes needed in its improvement program.

As shown in Table 5.1, there are three principles for each category with the exception of operations and capacity, which has five. The first few principles 1, 2, 3, 4, and 6 contain most of the material relating to MTO companies that tends to be missing from previous WCM models in the literature.

The main objectives of the first category, “generate enquiries/sales”, are (a) to provide a quick response to customer enquiries (b) to translate customer enquiries into product specification and design, and (c) to make the necessary plans to ensure that operations can meet the customer’s goals. Under the second category, “operations and capacity”, the shop floor operation is organised to help ensure a steady flow of materials. Activities include determining lead-time, set-up time, preventive maintenance, housekeeping and scheduling. The next category, “human resources”, refers to the improvement of the company’s workforce and finally the fourth category of the SHEN model, “general continuous improvement”, covers the aspects of quality and performance measures, benchmarking and marketing.

Table 5.1: *SHEN categories and principles*

Category	<i>SHEN principles</i>
Generate enquiries/sales	<ol style="list-style-type: none"> 1. <i>Integrate the functions of production and marketing in all processes;</i> 2. <i>Design for products, processes and improved supplier relationships;</i> 3. <i>Collaborate with customers;</i>
Operations and capacity	<ol style="list-style-type: none"> 4. <i>Simplify the shop floor;</i> 5. <i>Seek simple, flexible, movable, low-cost equipment in multiples;</i> 6. <i>Improve scheduling and workload control to cut flow times;</i> 7. <i>Cut the start up/ changeover time and improve preventive maintenance;</i> 8. <i>Improve information flow;</i>
Human resources	<ol style="list-style-type: none"> 9. <i>Make rapid improvements in skills and flexibility;</i> 10. <i>Have systematic rewards, recognition and monetary payment;</i> 11. <i>Everybody involved in change and strategic planning – to achieve a unified purpose;</i>
General continuous improvement	<ol style="list-style-type: none"> 12. <i>Improve quality and implement appropriate performance measures;</i> 13. <i>Gather customer feedback and benchmarking;</i> 14. <i>Promote/market/sell every improvement.</i>

Table 5.2 and Figure 5.1 summarises the relationship between the new model and the previous literature, showing which aspects of the model come directly or partially from Schonberger's (1996) model and which come from other parts of the literature. It can be seen that there are only two principles that have a direct full link, for the most part it has been necessary to make adjustments in the emphasis or to add new material for the reasons given in chapter 4.

Table 5.2: *The relationship between Schonberger (1996) and the SHEN model*

1. *Integrate the functions of production and marketing in all processes*- This is a new principle and not available in Schonberger (1996).
2. *Design for products, processes and improved supplier relationships* – This is a new principle but the issue of reducing the number of suppliers from Schonberger's (1996) principle 5 is incorporated.
3. *Collaborate with customers* - This principle is new, though there has been a very minor influence from step 2 of Schonberger's principle 1.
4. *Simplify the shop floor* – This is a new principle but the issue of housekeeping from principle 14 in Schonberger's (1996) model is relevant.

5. *Seek simple, flexible, movable, low-cost equipment in multiples* – The title is similar to principle 15 in Schonberger (1996), but the 5 steps have all been redefined.
6. *Improve scheduling and workload control to cut flow times*– This is a new principle but the aim of cutting flow times from Schonberger’s (1996) principle 6 is relevant, though the methods of achieving this are totally different.
7. *Cut the start up/ changeover time and improve preventive maintenance* – Set up time reduction from Schonberger’s (1996) principle 6 and preventive maintenance from Schonberger’s (1996) principle 14 are relevant but the methods of achieving them are different.
8. *Improve information flow* – This principle is related to principle 12 in Schonberger’s (1996) model. However, the idea to “fail-safe” the problems has been removed, and several of the steps in the new principle are quite different to those in Schonberger’s (1996) principle 12.
9. *Make rapid improvement in skills and flexibility* - This principle uses some of the ideas in Schonberger’s (1996) principle 8, but nearly all the steps are different.
10. *Have systematic rewards, recognition and monetary payment* – The title is slightly changed and the five steps are slightly modified from principle 9 in Schonberger (1996).

11. *Everybody involved in change and strategic planning – to achieve a unified purpose* – Ideas from principles 4 and 11 in Schonberger's (1996) model have been merged into this new principle.
12. *Improve quality and implement appropriate performance measures*- This principle uses some of the ideas in Schonberger's (1996) principles 10 and 13, but nearly all steps are different as less emphasis is given to the use of the process capability index and the QSFV metrics.
13. *Gather customer feedback and benchmarking* - This principle is related to principle 2 in Schonberger's (1996) model. Many of the issues are the same, although some of them are ranked differently. For example benchmarking is at step 5 rather than step 3.
14. *Promote/market/sell every improvement*- The title is maintained and the five steps are slightly modified from principle 16 in Schonberger (1996).

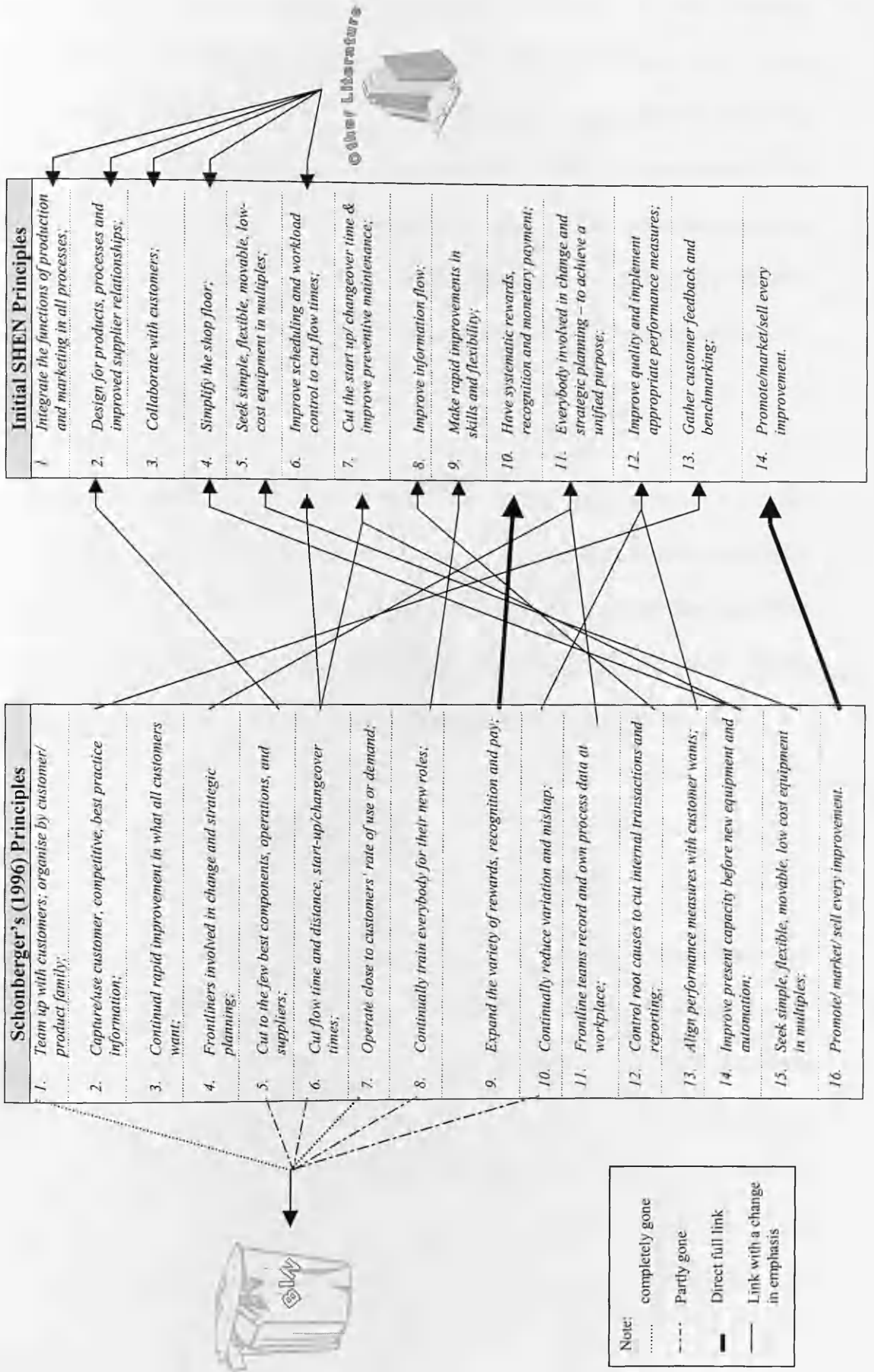
As discussed in Chapter 3, much of the material contained in Schonberger (1996) is a combination of material from the literature on best practice, TQM, JIT and so on. However, this is not shown in Figure 5.1, nor covered in this chapter as these links are discussed in section 3.1.6 and summarised in Table 3.1.

It is also important to note that some of the principles that are described as applicable in Table 4.2 in Chapter 4 are not necessarily used in full in the new model. This was

thought to be appropriate in order to keep the number of principles to a manageable number and to give an appropriate emphasis to each of the issues raised. Where it was felt to be appropriate to merge issues from two of Schonberger's principles together, this was due to some overlap in the issues or their underlying concepts. The principles themselves are described in greater detail later in the chapter, but some justification for the merging of issues is given below. Firstly, in principle 7 of SHEN, the issues of set up time reduction and preventive maintenance are combined because it was felt that with greater expertise of preventive maintenance, shop floor workers will become more familiar with the machinery and tools, and therefore they should be able to search for mechanical ways to reduce the set up time further. Of course, this is only one aspect of set up time reduction (Shingo (1988)), but this aspect leads to some overlap of the two issues included in the new principle 7.

Secondly, in principle 11, Schonberger's (1996) principles 4 and 11 are combined because it was thought to be appropriate to bring together the issues of the involvement of workers in strategic planning and of recording/owning process data at the workplace. The underlying concept of these two issues is to make use of the employees' expertise, treating them as a source of ideas rather than just machine operators. Thus the similarity in the underlying concept justifies the inclusion of these issues under one principle heading. Thirdly, in principle 12 in the SHEN model, principles 10 and 13 are combined because the underlying issues on quality in principle 10 is also an important aspect of the performance measures in principle 13.

Figure 5.1: The derivation of the SHEN model



Finally, with respect to principle 13 in SHEN, the issues of gathering customer feedback data and benchmarking are maintained in the same principle, as was the case in Schonberger's (1996) principle 2. This was thought to be acceptable because they are both considered to be external information which the company must collect. The first source of external information is the customers' feedback data, then the customer needs data, best practice data and finally benchmarking. It was believed that the first is the easiest, cheapest set of information to obtain whereas benchmarking is expected to take a considerable amount of time and/or to be more expensive.

Given the way in which the model is intended to be used, the way in which the issues are grouped into principles is not particularly crucial. The purpose of using principles in the SHEN model is to make the issues easier to remember rather than providing improvement stages for exactly the same aspects of operations management. The use of the steps within each principle is discussed further in the following section.

5.2. The five step improvement scale

The number of ranks/steps within each principle is probably one of the most controversial issues in this model. Aaker *et al.* (1995) claimed that due to difficulties of ranking, the company usually cannot meaningfully rank more than 5 or 6 objects. "The problem is not with the rankings of the first and last objects but with those in the undifferentiated middle" (Aaker *et al.* (1995)). The author also believed that the reliability of the advice will drop if there is four or less than a three-level scale. Fewer levels mean that little advice can be given to the company on how to go for the next improvement.

Therefore, the SHEN model favours the continuing use of 5 levels as in Schonberger's (1996) model. It might seem artificial to force five steps into each principle, but the advantage is that it makes it easy to remember if all the principles have the same number of steps. Also the five levels seemed to fall naturally out of the principles as they were developed. However, during the analysis of the results of the case study research, the number of steps will be reviewed if it seems preferable not to maintain five steps in all principles.

It is also important to note here that the five steps are not intended to be used as part of a scoring system, as has been the case in previous models such as Schonberger (1996). Indeed, it could be argued that scoring companies is not possible using any WCM concept as they are not precise enough to be used for such judgmental purposes. Rating or scoring is only possible if the numbers of the steps represent equal increments of the attribute being measured (e.g. the Likert, Thurstone scale). In such a case, the differences can be compared; for example the difference between 1 and 2 is the same as between 2 and 3. This makes it possible to compute an arithmetic mean from the scores and the data is referred to as an "interval scale".

However in the SHEN model, it is not possible to distinguish the exact value/ amount of difference between the steps in each principle. Aaker *et al.* (1995) describe scales of this type as "ordinal" rankings. According to The New Webster Encyclopedic Dictionary of the English Language (1997), an ordinal ranking refers to any numbers that express degree, quality or position in a series, as first, second and third etc. Aaker *et al.* (1995) claimed that "ordinal" rankings provides information on the differences

between the improvement activities but without indicating the exact amount of difference. Therefore it is not possible to compute a mean ranking in ordinal scales because the differences between ordinal-scaled values are not necessarily the same (Aaker *et al.* (1995)). For example being in level 4 in one principle doesn't mean being twice as good as level 2.

Therefore, the steps will be conferred based on the five levels of attainment, using level one for the lowest and level five for the maturity level. The level 1 signifies that the company is in the first step of implementing WCM practices and needs to improve. The next levels, 2, 3 and 4, signify that the company is moving toward implementing world class practice. Level 5 is the maturity stage for the MTO company. However, this is not the end of any improvement program as described later in the final chapter.

It is worth noting that it is also a possibility that a MTO company may go to a higher step without having attained one or more of the preceding steps. This is because some steps are not easy to array in order and in this situation an arbitrary decision has to be made to rank the issues.

5.3. Detailed explanation of the first version of SHEN

This section discusses each of the principles in greater depth. The main aim of this section is to identify what is appropriate to achieve at each of the five “levels of attainment” for each principle.

It is important to note that, given the diversity of MTO firms, not all firms will be able to proceed to all five stages in every principle. For instance, step 4 and 5 in principle 2 are essential for RBC companies but less relevant to VMCs. Therefore, it is likely that the highest level of achievement for VMC's will be level 3. However, as discussed in Chapter 1, it was initially thought desirable to try to develop one model that covered all the issues for RBC and VMCs, for small and medium enterprises, and for MTO companies in the range of ETO1 to MTO3, as classified by Amaro *et al.* (1999). The issue of whether more than one model is needed will be addressed in detail in Chapter 10.

Principle 1: Integrate the functions of production and marketing in all processes.

The importance of achieving a strong fit between production and marketing in support of the overall corporate strategy has been a central tenet of the manufacturing strategy literature (Bozarth and Berry (1997)). As discussed in the final section of chapter 4, it is necessary for the production planning and marketing departments to work together to determine the bidding price and delivery date to be quoted for each job.

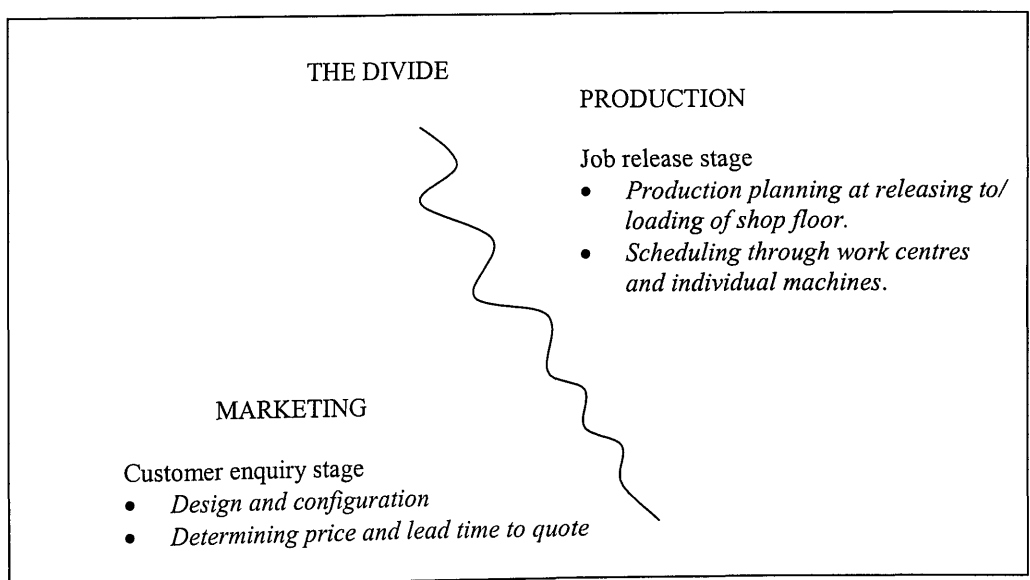
In measuring achievement in this principle, the following five steps are proposed:

- 1. Initial understanding between production and marketing;*
- 2. Production and marketing functions work together in responding to customer enquiries;*
- 3. Having a systematic data base system to enable MTO companies to respond to customer enquiries;*

4. *Achieve 50% reduction in time to respond to customer enquiries;*
5. *Understanding its competitors and having a systematic method for calculating price and delivery lead-time (i.e. strike rate matrix).*

At the one point level, there should be at least a general understanding between the production and marketing section to achieve common company goals. As has been discussed in more detail in Chapter 4, this means that instead of production looking to reduce costs and marketing looking to maximise sales, there is understanding that it is overall profits that is the most important objective. At the second level these two sections are required to work together during the customer enquiry stage so that customer demands are agreed to be realistic by production, as well as competitive by marketing. A deficiency of co-ordination between marketing/sales and production at the customer enquiry stage can lead to confirmed orders being delivered later than promised and/or being produced at a loss.

Figure 5.2: *Marketing and Production divides (adapted from Kingsman et al. (1993))*



As indicated in figure 5.2, this lack of co-ordination has typically meant that the Marketing Department alone deals with the customer enquiry stage, maybe with some interaction with engineering. Then the accepted job is handed over to the shop floor at the job release stage and it is only then that Production consider the implications of the job on shop floor capacity and the current planned schedules. If Production is involved earlier, then the effects of new orders can be anticipated sooner and any necessary changes in capacity can be provisionally planned in advance.

For the third level, MTO companies need to have a systematic computerised database system to respond to customer enquiries. This could reduce the time in the process of preparing the cost estimates and the paperwork for bids.

At the fourth level, a 50% reduction in estimation time to respond to customer enquiries is required. The target of 50% was thought to be realistic once the database is properly on place and desirable from a customer perspective as the time to respond to customer enquiries can be too long (Henderson (2001)). However consideration has to be given to the accuracy of the cost estimates produced. The feasibility of being able to produce the order with the current work load at different delivery dates needs to be evaluated together with any extra costs incurred. Hendry *et al.* (1992) and Kingsman *et al.* (1993) have developed a decision support tool for integrating the marketing and production functions so that the objectives of both parties are taken into account when bids are made in response to each customer enquiry. It may be that a decision system of this type would also need to be in place to achieve step 4 of this principle.

Maximum points will be given if the company have developed a systematic method for calculating the price and delivery lead-time. For example, Kingsman *et al.*(1993), have developed a mechanism to improve the choice of price and lead time to quote; this method is known as the “strike rate matrix”. With the “strike rate matrix” the “probability of winning” an order based on various prices and delivery dates can be determined. In brief, it is necessary to gather data on bids that have been tendered in the past including those lost and those won. For those lost, this means collecting data about the company’s competitors, either indirectly by ringing the customers to compare the price tendered by its competitors or by contacting the competitors direct.

Principle 2: Design for products, processes and improved supplier relationships.

Principle 2 is to cut out wasteful practices in product design and delivery. Advice within this category includes the need to have a good understanding of the design so that the quality tolerance can be brought close to the target value or specification. Improving the design is very important to make the product easier to manufacture with less error. Once this is done, production becomes smoother and manufacturing can then proceed more easily with less need for inspection and test, which add no value.

The five steps to measure the firms’ achievement under this principle are as follows:

1. *Train employees in understanding all the product specifications, product design rework and purchasing process/ knowing their suppliers;*

2. *Having a computerised design database with designs that can be altered for new orders;*
3. *Having a minimum number of parts, forgings or suppliers for each product;*
4. *Achieve 30% “repeat business” which makes it possible to establish partnerships with some of the suppliers;*
5. *Achieve 50% “repeat business”.*

At the one point level, the shop floor should be a source of ideas and the machine operators should be trained to understand the product design process. Having a computerised design database which can be modified for new orders in the second point level can give a lot of advantages to MTO. It can reduce the time for product design which in turn can shorten the response time to customer enquiries. Where possible, some basic designs may be stored in a computer and modification based on customer's needs could be made for each new order. Even if no basic design exists, it may still be possible to modify old orders rather than starting from scratch each time.

At the third level, the company has successfully reduced the number of suppliers for its product. As described in Chapter 4, the idea of reducing the number of suppliers in MTO may be achieved through the commonality of parts or 'forging'. However, any improvement in company performance resulting from changes in this area will be much smaller than those expected and achieved by the producer of more standard products (Hendry, (1998)). Therefore no percentage figure is given, but the company must have addressed this issue and be confident that parts, forgings and suppliers have been reduced as much as possible.

In terms of “repeated business” referred to in steps 4 and 5, the MTO firm may establish a long term continuing repeat business with a specific customer and for a product specifically produced for that particular customer. One of the aims for repeat business is to make the business secure with guaranteed jobs for a reasonable period into the future. A firm who has achieved repeated business could shift toward good partnerships with its suppliers. With partnership, the MTO companies may stay with few suppliers and enable the learning curve to work for the benefit of both parties. Some contracts in a “repeat business” specify the quantity of purchasing for the next few months and provide the forecast for the rest of the year, whilst other contracts may not stipulate the exact quantity. However in both cases, these contracts can reduce the manufacturing cost and thus reduce the costs to the customer which is important to gain competitive advantage in the MTO businesses. As stated earlier, these two steps of this principle are included for the RBCs, and may not be achievable for VMCs.

Principle 3: Collaborate with customers.

Customers are the primary reason for being in business (Shores (1994)). According to Grieco (1996), the cost of developing a new customer is estimated to be as much as 5 times as the cost of keeping an existing one happy. And it takes months to develop a customer and only days to lose that same customer. The five levels under this principle are as follow:

1. *Having good communication among employees, a common understanding of organisational objectives and customers needs;*

2. *Establish a personal relationship between employees and customers;*
3. *Getting customer representatives on the project;*
4. *Company helping the customers define their needs into product specifications and design;*
5. *Helping the customers meet their goals, rather than providing customer's wants.*

The first level of this principle requires a common shared understanding of the company business among employees, with particular reference to customer needs. Issues of this type are applicable to all SMEs. In fact, the smallness of the company makes the task of communication easier to achieve.

At the two-point level, the MTO company can make effective use of a good relationship with its customers to ensure complete satisfaction on current jobs and to gain more jobs in the future. To this end, the company may assign one particular individual to have constant contact with one particular customer. That individual will be responsible to deal with any kind of requirements needed for that particular job. Customer requirements may change during any stage of the project. This person must be very clear on the customer requirements because one of his/her jobs is to transform requirements into service specifications. Getting customers' involvement on a current project at the third level is the next improvement for the MTO company to aim for. For example, the two parties may work together to ensure appropriate standards of quality are attained. The fourth level requires the company to help its customers to define their needs into product specification and design. The customer may come with some rough ideas and the company may translate the ideas into product specifications and drawings. The highest level will be achieved if the MTO company help his

customers to meet even more general goals, rather than providing what the customer knows it wants. For instance, the company may help the customer to design a new module or product that is beyond the customer expertise.

Again, this principle may be more appropriate to RBC than VMC firms, but is thought to be worth including for all firms at present in order to aim for more repeat business if possible. Of course, this principle overlaps with the previous one and it could be argued that steps 4 and 5 from principle 2 should be removed and become steps 6 and 7 for this principle. However, the issue of repeat business affects the ability to reduce the number of suppliers and so on. So its inclusion there is also logical and at this stage, it was thought best to stick to the initial decision of having a uniform number of steps in each principle.

Principle 4: Simplify the shop floor

Under this principle, improving visibility, having efficient storage systems, and efficient housekeeping are the main contributing factors. The five levels are as follows:

- 1. Improve visibility, use simple storage systems to reduce search times;*
- 2. Improve locations of raw materials, WIP etc. to cut distances for movement of materials and tools;*
- 3. Train shop floor employees on the importance of using the storage systems and of taking responsibility for their own housekeeping;*

4. *Implement housekeeping so that work areas are clean as well as ensuring that the storage systems are properly used;*
5. *The operator takes over his own housekeeping.*

The one point level requires the company to improve the shop floor visibility to make the movement of raw materials and tools easier. One of the important tasks for the shop floor manager is to reduce the time for searching for materials and components. Time is sometimes squandered searching for components or worse, making parts that are in fact already available. The second point level requires the firms to improve their storage system further so that they can be deemed more efficient. For instance, putting the raw materials near to the area in which they will first be used wherever possible can eliminate the need for a warehouse of components.

At the three points level, the firm is required to provide training to its workers on the importance of using the storage systems and of taking responsibility for their own housekeeping. At the fourth level the firm is required to discipline its workers to do the housekeeping job. The concept of “5S” housekeeping comes from the Japanese words “Seiri, Seiton, Seisou, Seiketsu, Shitsuke” which means liquidation, tidiness, sweep, cleanliness and discipline (Morton (1994)). According to Schonberger (1996), Boeing’s version of “5S” means sorting, sweeping, simplifying, standardising, and self-discipline. Everything is marked or labelled. All items such as brooms, mops, and other cleaning materials are neatly placed in designated places when not in use. Display boards are used to describe the 5 S’s and show photos of proper and improper housekeeping in the company. At this level, management may need to keep reminding

its employees to tidy up their own areas, but nonetheless improved housekeeping should result.

The five-point level requires the shop floor operators to take over their own housekeeping. Under this concept, the employees maintain their own equipment without supervision and keep everything in a benevolent order.

Principle 5: Seek simple, flexible, movable, low-cost equipment in multiples.

As stated in section 4.4.3, smaller machinery is easier to maintain, is cheaper to buy and is easier to move and relocate when necessary to produce a new type of product. In MTO companies, there is a tendency to employ NC and CNC machines. According to Garsombke et al. (1989), numerically controlled machinery (NC) was one of the earliest technological advances introduced to SME manufacturers. A study by Liberatore and Titus (1986) found that more than half of the firms studied used CNC machines and those firms averaged only 1.8 CNC machines (6 percent) among 31 machine tools in the shop. This implies that SMEs began to employ CNC machines some time ago to increase their competitiveness. Although, no more up-to-date figures are available, it is the author's belief that the usage of CNC machines has increased in MTO SMEs over the last decade or so. This policy is acceptable if the machines are still flexible and movable, but should be questioned if this is not the case. Therefore, this principle suggests that small and affordable NC/CNC equipment should be chosen whenever possible, and even this should only be used if appropriate alternatives cannot be found.

The five levels of achievement under this principle are as follow:

1. *Establish a policy to purchase and maintain equipment as required to meet goals;*
2. *30% of equipment is highly flexible/movable;*
3. *50% of equipment is highly flexible/movable;*
4. *80% of the equipment is highly flexible/movable;*
5. *99% of the equipment is highly flexible/movable.*

At the first point level, the company should make sure that the benefits of simple, flexible machinery are understood. This means establishing a policy to identify the objectives of the firm and then look for suitable types of machinery that may minimise the capital costs whilst meeting those objectives. Having expensive equipment such as CNC machine does not guarantee the company's success. Where suitable alternatives can be found, then the best way may be to have affordable equipment in multiples.

The second level of achievement requires the MTO firm to have 30% of the equipment flexible/movable. The third, fourth and fifth level of achievement requires the equipment to be even more highly flexible or movable. For instance the five point level of achievement requires 99% of the equipment to be flexible/movable. It is important to note that the five levels for this new principle are a little bit tougher than in Schonberger (1996) because the flexibility of the machinery is believed to be easier to achieve in the MTO sector. However the idea of equipment owned by focussed teams/cell is completely left out.

Principle 6: Improve scheduling and workload control to cut flow times.

In MTO operations, a job waits in a queue with other jobs, waiting its turn for processing. It waits some more while someone does the setting up process for that kind of job. After processing it waits again to be transferred. After it transfers to the next station, the sequences of wait, set up, work, wait and move starts again. A job's processing time is only one portion of the total time it spends on the shop floor. Examples of activities that do not add value are those that add cost to the product but do not improve it in any way, such as moving, storing, setting up, inspecting and waiting. When the MTO company attempts to better control flow time, they generally focus on reducing as much as possible the activities that do not add value.

Methods of controlling the Workloads or queues to better control flow times, and hence manufacturing lead times, in the MTO sector have been discussed in Chapter 4. They include an approach called Workload control (WLC) or Order Review and Release (ORR); finite/infinite scheduling along with dispatching rules or just improving the storage systems and housekeeping as discussed in principle 4. Whatever the method, the issue of reducing lead times is very significant for MTO companies because they are frequently in a position of having to quote lead times to their customers before production begins and therefore the length of the manufacturing lead time is visible to the customer.

With regards to the above issues, the five levels achievement under this principle are as follows:

1. *Train associates in job shop sequencing, queuing limitation, workload control, handling priority;*
2. *Having a practical, simple and easily implemented workload control or scheduling system which can be modified as priorities change;*
3. *Having a computerised database system for scheduling/ workload control;*
4. *Achieving average reduction of flow time by 30%;*
5. *Achieving average reduction of flow time by 50%.*

At the first point level, everybody on the shop floor must be trained to understand the job shop sequencing, queuing limitation, workload control and handling priority. Last minute production control decisions are often made by shop floor workers and therefore the principles of production control should be understood by all relevant personnel, not just stored in the head of one employee, the Production Controller. At the two-point level, the MTO production control system does not need to be computerised. In fact the MTO company can make effective use of manual production control boards to display “work to lists” or to schedule the jobs. However there should be some form of scheduling or workload control system in place which should reflect job priorities in its sequencing decisions.

The third level requires the MTO company to use computer software in its production control system. However, to implement a workload control system of the type described in Chapter 4 would require the implementation of computer software that is not yet readily available on the software market and hence ‘in-house’ systems would need to be developed by using simple computer packages (e.g. EXCEL). Alternatively as described in Chapter 4, it may be possible to consider the use of software that’s

readily available, such as finite capacity planning techniques which load the planned jobs onto the machines according to the available capacity constraints. The fourth and fifth level of improvement suggests that the company should achieve some improvement in its flow time. As long as the MTO firm can achieve these objectives, it doesn't matter what type of scheduling or workload control method is used.

Principle 7: Cut the start up/changeover time and improve preventive maintenance.

Another aspect of non-value added time is machine down time. If preventive maintenance can reduce this, then flow times can be reduced further. Similarly, reductions in set-up/changeover time will also lead to shorter manufacturing lead times. Cutting set up time also permits the shop floor to increase the plant capacity by making the machine available for use for longer periods.

The MTO five levels are as follow:

- 1. Train associates in set-up/ changeover reduction and basic preventive maintenance;*
- 2. Achieving 20% average reduction in set-up/ changeover time;*
- 3. Operators can take over their own preventive maintenance;*
- 4. Achieving 30% average reduction in set-up/changeover time;*
- 5. Employees achieve 50% reductions in set-up/ changeover times across all processes.*

At the one point level, the MTO company can initiate the above activities through small steps in the form of education and training of its employees. The shop floor

members, on a selective basis, could be trained to reduce set ups and do basic preventive maintenance. The second level requires the set-up times to be reduced by 20%. There are many ways of reducing set-ups. For example, ensuring tooling is stored in a convenient place can save a lot of time. Changing fittings so that they are slot-in rather than screw in and ensuring that there is adequate manpower to operate machines when a change of set-up is needed.

The third level requires the machinists to take over their own preventive maintenance. Preventive maintenance requires that equipment must be maintained to meet the required process. Operators can do simple things like adding lubricant, checking for wear, listening for unusual vibration or repair minor problems. In addition, the tools, and barrels of lubricants can be placed nearby the machines in exact locations for easy grasp. Having appropriate maintenance policies will enable the shop floor to maximise the usage of the machines. The higher levels, 4 or 5, requires the company to search for ways to reduce its set up time further by 30% at level 4, and then by 50% at level 5, across all processes.

Principle 8: Improve information flow.

The two main issues that underlie this principle are to eliminate workflow transactions and to simplify the communication process internally and externally. The five levels under this principle are as follows:

- 1. Job priorities are clearly understood by all and everyone is working to the same plan;*

2. *Having a systematic method to communicate the plan including manual systems such as a planning board or 'work to lists' produced by an appropriate software package;*
3. *Having information about quality, cost, orders, delivery, and design that is readily available anytime to all in the factory;*
4. *Workflow, quality, internal scheduling and labour transactions cut by 25%;*
5. *Internal transactions cut by 50% and 50% of external transactions are done by fax/ Internet/ EDI.*

The first level requires that job priorities are clearly understood by employees and that everyone in the shop floor is working to the same plan. It may be a rough, or unwritten schedule but it must at least be understood by all employees. The second level requires the company to have a systematic control system to cut internal transactions. Conceivable techniques include manual systems such as a planning board or 'work-to-lists' produced by an appropriate software package. If the latter, information may be available via the computer terminal, thus reducing internal paper transactions. The third level requires that employees should be clear about the targets (i.e. on quality, cost, orders, delivery, design) and standards of performance required, whatever those may be. They should be able to track all kinds of information on the shop floor.

Advice for four to five levels includes the need to cut internal and external transactions. Examples of internal transactions are the use of "manual" tracking records to register the arrival of raw materials/components and the dispatch of finished goods, which are considered as "time-wasters" for managers. Such practice

leads to increases in internal transactions. An alternative solution is to automate the process. Hendry *et al.* (1995) suggest that a bar coding system is a faster method of data collection than the manual. With a bar coding system, the company can improve the recording of stock movements and the receipt of product against works orders (Hendry *et al.*(1995)). Regarding external transactions, the MTO firm can achieve reductions through the usage of electronic data interchange, fax machines and computer links. Information on delivery, ordering of parts, designing and so on can now be exchanged very quickly between all the parties involved in the process.

Computer networks are beginning to play an important role in the successful operations of small businesses (Baar (2000)). Many online services can be used by the MTO firm to improve the process such as electronic mail (e-mail), sharing of documents, proposals, files, marketing catalogue, order processing, networking and business and market research. E-mail for example, can be a quick economical way to communicate worldwide. This is very good scheme for small companies that do not have access to a large budget.

Principle 9: Make rapid improvements in skills and flexibility.

Due to the nature of MTO processes, the employment of well-trained and highly skilled employees is essential if the company is to provide the levels of product flexibility and customisation required. Thus, the MTO five levels under this principle are as follows:

1. *Implement a training programme for all associates to increase relevant skills;*
2. *80% of associates are flexible in skills and able to work on any machine;*

3. *99% of associates are flexible in skills and able to work on any machine;*
4. *Experts teach operators to do repairs; downtime cut by 50%;*
5. *Operators become technicians; downtime cut by 80%.*

At the first level, the company should establish what training needs exist for individuals and determine their level of priority. At this stage, it is also essential to make sure that individuals are enthusiastic about this issue and hence encouraged to take part in any skill improvement opportunities. The second and third levels require the MTO company to reach a point whereby first 80% and then 99% of workers have the flexibility to work on any machine. These high levels are deemed feasible because a high skill base and a high degree of flexibility are inherent characteristics of the MTO firm.

At the fourth level, training and instructing colleagues may become part of everyone's regular job, especially those that have achieved a level of expertise in an aspect of the operation processes. These experts may be internal or external people but internal is preferable because both the trainer and trainee can communicate several times even after the training session. At the fifth level, the machine operators become technicians/ experts that can handle machine repairs and downtime is cut by at least 80%.

Principle 10: Have systematic rewards, recognition and monetary payment.

Human resource management and the effective management of employees also emerge as a key variable in the survival of small firms (Marlow and Dean (1993)).

Authors such as Deshpande and Golhar (1994) claim that a number of workforce characteristics (such as concern for the firm's success, ability to inspect work, worker flexibility, ability to work in-groups and self-discipline) are considered to be more important in smaller rather than larger firms. As companies gain high levels of achievement in many of the other principles, such as principles 7 and 8, then the role of the worker begins to expand beyond simply making the product. Instead they are involved in multi-skilling including machine repair work and are involved in continuously attempting to improve their own working environment. Therefore, given that employees contribute in many ways, they should be compensated in many ways too. It is suggested that the five level achievement stages for this principle are as follows:

1. *Having a systematic performance appraisal system;*
2. *Systematic public recognition/ celebration of achievement;*
3. *Variety of low-cost awards to both teams and individuals;*
4. *The company is investing in employees via training, cross training, cross careering;*
5. *The company reward for skills/knowledge; team/unit bonuses.*

Level 1 suggests that the company should start to establish a systematic performance appraisal to increase the workers motivation toward work. A supervisor or floor manager can play a role in the process by providing employees with performance feedback related to their job. Under the performance appraisal concept, at least once a year the supervisor and employee work together to agree goals for the employee. Then at the end of the period the employees need to sit down with supervisors and talk about what has been achieved, at the same time as devising goals for the next

appraisal period. According to Clifford (1999), performance evaluation should be a time to communicate both ways, what the employees should do and what the organisation should do. The talking should not just be concerned with the employee performance but also the supervisor's performance in terms of what the supervisor might do better to guide the subordinate to be successful in the future. It should be a chance for employees to provide information to supervisors on how management can support them better so that they can be more productive.

Systematic recognition in level 2 may include monthly, quarterly and yearly awards for reductions in the number of defects, mishaps, scrap or unsafe incidents; for any suggestions; and for improvements in term of housekeeping and so on. Winners may be celebrated in a public meeting, in a newspaper article or in the form of photos displayed on the shop floor. Level 3 is concerned with various kinds of low-cost awards given to employees such as a dinner at a fine restaurant, holidays or a ticket to an entertainment event.

At the fourth level, the company is required to encourage employees through training and cross training. This kind of training may be geared towards management skills to help workers increase their self-esteem and further their own career aims. In some cases, the company may sponsor its employee to pursue a relevant higher level of education on a part time or full time basis at the local college/institution. Finally at the fifth level the company awards bonuses, merit pay, and pay for knowledge in addition to the basic salary.

Principle 11: Everybody involved in change and strategic planning – to achieve a unified purpose.

Most MTO companies have people categorised as “front-line employees”, “bosses”, or “staff experts” who are inspirational leaders. The employees gather and analyse their own process data and thus have the power of process knowledge. Bosses, experts and employees are working together and share the knowledge to improve the process.

The five levels under this principle are as follows:

- 1. Having strategic planning;*
- 2. Sharing information and records with shop floor employees;*
- 3. The frontline employees/teams/supervisors use process analysis, plot trends;*
- 4. Encourage employees to make suggestions to improve the process;*
- 5. The company gains the involvement and commitment of customers in their strategic plan.*

Level 1 of principle 11 requires a MTO company to have a strategic plan. Strategic planning consists of an overall plan to effectively guide the company as a whole. Good examples of planning will specify the company’s strategic objectives (e.g. high quality products, low costs, short time to market) and give some indication of the methods for attaining them. For level 2, the company needs to inform workers about its strategic plan and share the relevant data (e.g. whether aims are being met) with its shop floor employees. At level 3, employees/teams/supervisors not only “own” the process data but also actively track its improvements, usually on the wall charts kept in their own areas. This process data may include data on reductions in defects and

non-conformities, flow times, set up times, housekeeping activities and so on. Some information related to quality processes such as scrap reduction, defect prevention may be used by functional teams, but other things like delivery date adherence may need to be done at supervisory level. However any done at the supervisory level must be displayed on the shop floor at appropriate locations.

At the fourth level, employee suggestions to improve the process become definite measures of process ownership. This links with the previous principle as companies may often wish to give a small monetary reward for any suggestion received. The fifth level is achieved if the company also gains the involvement and commitment of its customers in its strategic plan. For example, the MTO firm may face pressure to gain parts of the ISO 9000 series of accreditation from its customers. If so, then they may work together to plan for activities to achieve the ISO certification. However, it should be noted that for VMC's, the commitment of the customer will be considerably less than that which can be expected and achieved by the RBCs.

Principle 12: Improve quality and implement appropriate performance measures.

Quality applies to goods, services and processes. A good quality product has a minimum variation around the specified values, or is well within the quality tolerances. When the processes are improved the goods and services improve too. Quality requires a continual and rapid improvement in all processes. The idea is to find ways of preventing problems occurring in the process so that outputs of the process are always good.

The five levels are as follows:

1. *Establish a culture that supports continuous improvement in all processes;*
2. *Practice the principles of quality;*
3. *Training in universal customer wants: quality, speed, flexibility or value (QSFV);*
4. *QSFV are dominant performance measures;*
5. *Second order performance measures (e.g. labour productivity, variance) no longer managed.*

The first level requires the firm to establish a culture that supports continuous improvement in its processes. Usually, before any improvement can be made, the management needs to develop this type of culture, so that any new concept is welcomed and explored rather than being automatically criticised and thrown out. At the second level the quality practices may not be visible on the shop floor but the management is very particular about the quality in its processes. The third point level requires the company to provides training in universal customer wants (QSFV). As stated in Chapter 4, the MTO firm may have some prioritisation between these four objectives, and may even have other objectives that are more suitable. The key issue at this level is to train employees in the relative importance of the company objectives.

At the fourth point level in this principle the company objectives, which may include improvements in QSFV, become the dominant performance measures. At the fifth level, it is necessary to get rid of “second order” performance measures. The reason is that “second order” performance measures are irrelevant to the company’s real

business objectives. Presenting such data to the workforce every month will give negative signals. “We cut nonconformity, cut set-up times, cut the flow time, did the preventive maintenance, and what did it get us? Higher unit costs on the monthly cost report!” (Schonberger, (1996)). Of course investment in these activities requires additional costs but it shouldn't be part of the company's assessment or measurement. Presentation of such data to the shop floor could be made later, may be during an annual meeting when it is also possible to see that the investment has paid off and lead to improved company performance.

Principle 13: Gather customer feedback and benchmarking.

Customer feedback and benchmarking can be used as a tool to gather information that may lead to the increased success of a company.

The five levels achievement under this principle are as follows:

- 1. Gathering customer-satisfaction data, review complaints and make continuous improvement on products and services;*
- 2. Gathering customer-needs data;*
- 3. Gathering competitive samples and best practice data;*
- 4. All associates involved in customer/ competitive best practice;*
- 5. The company implement full-scale benchmarking for its processes.*

At the first level, systems are put in place to collect customer feedback and to review the customers' complaints. The former may include questionnaires sent with the

product on delivery or may mean telephoning customers on receipt of products. This data must be regularly reviewed, analysed and acted upon. Where there are complaints, it is necessary to take immediate action to 'fail-safe' the problems. Customer needs data at the second level means attempting to find out what the customers will require in the future. Similarly, at the third level, the competitive samples and best practice data can be used as a source of information for the company to improve its operations and be more competitive in the future. Competitive samples may include collecting samples of competitors' products. Clearly, this strategy requires identifying the products and service offered by competitors and how to make the company superior to its competitors. Best practice refers to additional data, which go beyond the product. For instance, filing systems, payroll systems and so on.

The fourth level requires the involvement of all employees and not only the managers to help the company strengthen its competitive status. This means that all employees may be involved in collecting competitive samples or customer needs data to search for better ways to operate the company. Finally the fifth level requires the company effort to go for a full scale 'benchmarking' in its operations. According to Beasley and Cook (1995), the five main reasons for company's benchmarking are "to change or strengthen the company culture; to increase the company's competitive advantage; to create awareness; to enhance operational awareness; to enhance operational performance and to manage the company strategically".

Principle 14: Promote/market/sell every improvement.

Promotion is a mix of activities that includes advertising, publicity, direct mail, telephone calls and sales presentation. Planning for promotional campaigns involves

choosing for appropriate advertising media, the audience, and the effectiveness of the message/campaign.

The five levels achievement under this principle are as follows:

1. *Having good advertisements with effective placing (newspaper, magazine, etc.) for the target customers;*
2. *Positive QSFV trends featured in selling, bids, proposals, ads;*
3. *Registration; certifications; local awards (ISO-9000, Ford Q1, state award);*
4. *Global/national awards (e.g., Baldrige);*
5. *Reverse marketing: Out of strength, you choose whom you sell to.*

At the first level, MTO promotional campaign may be made through trade exhibitions, trade journals, telephone calls, direct mail, internet web pages or the yellow pages phone book. For example, the Internet (Web Pages) is considered as one of the best places to advertise because it is fast and easy to access by the customers. The second level requires the special MTO features, which may include some of the QSFV or other performance measures, to be publicised. However, the third level requires a lot of company effort to gain international recognition such as state awards or ISO 9000 awards. The intention of having ISO 9000 recognition is to provide confidence to customers that the intended quality is being achieved and sustained. Nowadays, companies that do not conform to the ISO 9000 standards are likely to find that they will not be able to sell into certain markets, thereby reducing their sales potential (Shores, (1994)).

The fourth level requires MTO firms to go beyond ISO 9000 or state awards to aim for national or global awards. The fifth level of achievement for this principle is where the company can price itself out of the market, if it wants it to. If the company can build these practices, it is at a great advantage. The company can pick and choose the customers rather than the company itself searching for customers.

5.4 Summary Table

Table 5.3 gives a summary of the first SHEN model discussed in this chapter. As stated before, this model uses a five-point scale, with the highest level of attainment relating to point 5.

Table 5.3: The detailed steps of the first SHEN model

SHEN PRINCIPLES	Breakdown points - 1 to 5 ascending scales
<p>Generate enquiries/sales</p> <p>1. <i>Integrate the functions of production and marketing in all processes;</i></p> <p>2. <i>Design for products, processes and improved supplier relationships;</i></p>	<p>1. <i>Initial understanding between production and marketing;</i></p> <p>2. <i>Production and marketing functions work together in responding to customer enquiries;</i></p> <p>3. <i>Having a systematic data base system to enable MTO companies to respond to customer enquiries;</i></p> <p>4. <i>Achieve 50% reduction in time to respond to customer enquiries;</i></p> <p>5. <i>Understanding its competitors and having a systematic method for calculating price and delivery lead-time (i.e. strike rate matrix).</i></p> <p>1. <i>Train employees in understanding all the product specifications, product design rework and purchasing process/ knowing their suppliers;</i></p> <p>2. <i>Having a computerised design database with designs that can be altered for new orders;</i></p> <p>3. <i>Having a minimum number of parts, forgings or suppliers for each product;</i></p> <p>4. <i>Achieve 30% "repeat business" which makes it possible to establish partnerships with some of the suppliers;</i></p> <p>5. <i>Achieve 50% "repeat business".</i></p>

<p>3. Collaborate with customers;</p>	<ol style="list-style-type: none"> 1. Having good communication among employees, a common understanding of organisational objectives and customers needs; 2. Establish a personal relationship between employees and customers; 3. Getting customer representatives on the project; 4. Company helping the customers define their needs into product specifications and design; 5. Helping the customers meet their goals, rather than providing customer's wants.
<p>Operations and capacity</p>	
<p>4. Simplify the shop floor;</p>	<ol style="list-style-type: none"> 1. Improve visibility, use simple storage systems to reduce search times; 2. Improve locations of raw materials, WIP etc. to cut distances for movement of materials and tools; 3. Train shop floor employees on the importance of using the storage systems and of taking responsibility for their own housekeeping; 4. Implement housekeeping so that work areas are clean as well as ensuring that the storage systems are properly used; 5. The operator takes over his own housekeeping.
<p>5. Seek simple, flexible, movable, low-cost equipment in multiples;</p>	<ol style="list-style-type: none"> 1. Establish a policy to purchase and maintain equipment as required to meet goals; 2. 30% of equipment is highly flexible/movable; 3. 50% of equipment is highly flexible/movable; 4. 80% of the equipment is highly flexible/movable; 5. 99% of the equipment is highly flexible/movable.
<p>6. Improve scheduling and workload control to cut flow times;</p>	<ol style="list-style-type: none"> 1. Train associates in job shop sequencing, queuing limitation, workload control, handling priority; 2. Having a practical, simple and easily implemented workload control or scheduling system which can be modified as priorities change; 3. Having a computerised database system for scheduling/workload control; 4. Achieving average reduction of flow time by 30%; 5. Achieving average reduction of flow time by 50%.
<p>7. Cut the start up/ changeover time and improve preventive maintenance;</p>	<ol style="list-style-type: none"> 1. Train associates in set-up/ changeover reduction and basic preventive maintenance; 2. Achieving 20% average reduction in set-up/ changeover time; 3. Operators can take over their own preventive maintenance; 4. Achieving 30% average reduction in set-up/changeover time; 5. Employees achieve 50% reductions in set-up/ changeover times across all processes.
<p>8. Improve information flow;</p>	<ol style="list-style-type: none"> 1. Job priorities are clearly understood by all and everyone is working to the same plan; 2. Having a systematic method to communicate the plan including manual systems such as a planning board or 'work to lists' produced by an appropriate software package;

Human resources

9. *Make rapid improvements in skills and flexibility;*

3. *Having information about quality, cost, orders, delivery, and design that is readily available anytime to all in the factory;*
4. *Workflow, quality, internal scheduling and labour transactions cut by 25%;*
5. *Internal transactions cut by 50% and 50% of external transactions are done by fax/ Internet/ EDI.*

10. *Have systematic rewards, recognition and monetary payment;*

1. *Implement a training programme for all associates to increase relevant skills;*
2. *80% of associates are flexible in skills and able to work on any machine;*
3. *99% of associates are flexible in skills and able to work on any machine;*
4. *Experts teach operators to do repairs; downtime cut by 50%;*
5. *Operators become technicians; downtime cut by 80%.*

11. *Everybody involved in change and strategic planning – to achieve a unified purpose;*

1. *Having a systematic performance appraisal system;*
2. *Systematic public recognition/ celebration of achievement;*
3. *Variety of low-cost awards to both teams and individuals;*
4. *The company is investing in employees via training, cross training, cross careering;*
5. *The company reward for skills/knowledge; team/unit bonuses.*

General Continuous Improvement

12. *Improve quality and implement appropriate performance measures;*

1. *Having strategic planning;*
2. *Sharing information and records with shop floor employees;*
3. *The frontline employees/teams/supervisors use process analysis, plot trends;*
4. *Encourage employees to make suggestions to improve the process;*
5. *The company gains the involvement and commitment of customers in their strategic plan.*

13. *Gather customer feedback and benchmarking;*

1. *Establish a culture that supports continuous improvement in all processes;*
2. *Practice the principles of quality;*
3. *Training in universal customer wants: quality, speed, flexibility or value (QSFV);*
4. *QSFV are dominant performance measures;*
5. *Second order performance measures (e.g. labour productivity, variance) no longer managed.*

1. *Gathering customer-satisfaction data, review complaints and make continuous improvement on products and services;*
2. *Gathering data on future customer needs;*
3. *Gathering competitive samples and best practice data;*
4. *All associates involved in customer/ competitive best practice;*
5. *The company implement full-scale benchmarking for its processes.*

<p>14. <i>Promote/market/sell every improvement.</i></p>	<ol style="list-style-type: none"> 1. <i>Having good advertisements with effective placing (newspaper, magazine, etc.) for the target customers;</i> 2. <i>Positive QSFV trends featured in selling, bids, proposals, ads;</i> 3. <i>Registration; certifications; local awards (ISO-9000, Ford Q1, state award);</i> 4. <i>Global/national awards (e.g., Baldrige);</i> 5. <i>Reverse marketing: Out of strength, you choose whom you sell to.</i>
--	--

5.5. Conclusion

The new model, “SHEN”, groups its principles into 4 categories, each containing several inter-related principles. The category titles are generate enquiries/sales, operations and capacity, human resources and general continuous improvement. Each category comprises of three principles with the exception of operations and capacity, which has five. The first few principles from the lists 1, 2, 3, 4 and 6 contain most of the material relating to MTO companies that tends to be missing from previous WCM models in the literature. These include integration of the functions of production and marketing, the product design process, customers’ relationships and so on. The remainder of the principles are built/modified from generic, universalistic literature that is aimed at all manufacturing companies. The latter include issues on performance measurement, benchmarking, housekeeping, preventive maintenance, human resources and so on. However, even where this type of material is present, the principles have been carefully tailored to suit the high variety, low volume MTO environment. For example, it is rarely assumed that teams can be the basis for any changes for the reasons given in Chapter 4. In order to develop the model further, qualitative data from six case studies were collected. The following chapter describes how the inductive approach was used to collect this data.

CHAPTER 6

CASE STUDY DATA COLLECTION

As explained in chapter 2, data was collected from six case study companies, using several data sources including interviews, observation and archive data. To ensure the collection of rich data, several visits to the company were made in two stages. In the first stage, data collection was carried out using factory observations, archive data and semi-structured interviews with the managers, engineers, supervisor and shop floor workers, to discover current practice. The issues explored covered all those within the SHEN principles and allowed the interviewee to also discuss any other areas of improvement that they have contemplated or tried in the past. Altogether there were 20 major topics covering more than 50 questions designed for the interviews. Two versions of the questionnaire were designed, one for the management level and one for the other employees, as shown in Appendix 1.

The data were then analysed to determine areas of company strength and weakness. The results were explained in detail in a report sent to the company, which was then used as the basis for discussion at further meetings with the management.

In the second stage of data collection, a more open discussion was carried out based on the company report, which the company personnel had the opportunity to read in advance. At this stage, the management were also asked to comment on anything that had not been included in the model such as other areas of company strength; any

additional ideas the company had tried but abandoned; and other ideas that were currently being considered by management.

The six companies involved in the research comprised two small sized MTO companies, with between 10 to 49 employees, and 4 medium sized MTO companies, with between 50 to 140 employees. Table 6.1 provides general background information on the six companies involved in the study.

Table 6.1: *General background information on the companies in the survey.*

Co.	Location	1998 Turnover (in million £)	Number of employees	Business Line(s)
A	Morecambe	1.1	20	Precision tools engineering
B	Carnforth	0.6	16	Furniture industry (i.e. kitchen, bedroom)
C	Garstang	4.0	90	Silos and feeding equipment for the agricultural industry
D	Leyland	5.5	140	High precision finished sheet metal components
E	Manchester	4.5	65	Special doors, (i.e. fire proof, sound proof).
F	Morecambe	3.0	86	Sheet metal and light metal fabrication products for diverse machines

The classification of the six SMEs into small or medium was done in reference to the European statement that "... the company is considered a medium sized enterprise if it has between 49 and 150 employees and annual turnover of below 40 million ECU (approximately £24 million) or annual balance sheet total of under 5 million ECU

(approximately £3 million), and a business with less than ten employees will be regarded as a “very small” firm”. (Anonymous (1996)). The six companies and the data collected from each one are described in more detail below in sections 6.1 to 6.6. Then section 6.7 discusses the logic used in choosing these particular companies and indicates how they comprise an appropriate set of MTO companies to further develop the SHEN model.

6.1. Company A

Company A is a 20-employee privately owned MTO company established in 1968. The company core business is in precision engineering, which primarily involves the manufacture of a wide variety of parts and products for many different customers. Examples of products are rollers, shafts, torsion bars and tubes up to 5 metres long.

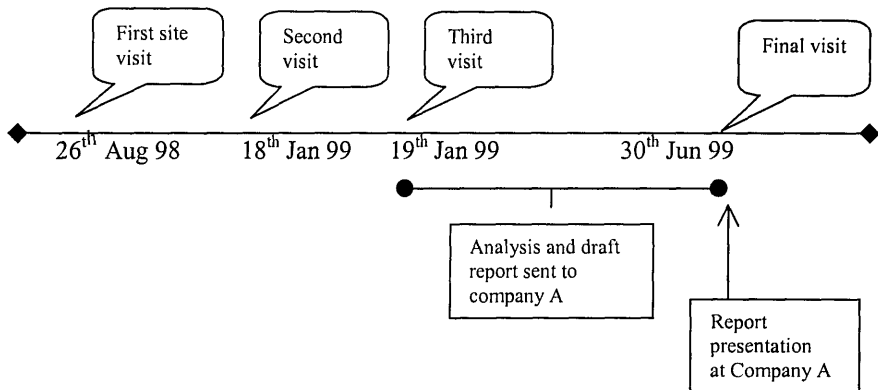
The company is considered to be a small size company, with £0.35 million net assets and £1.1 million turnover per year. Although small, the business has developed into a thriving engineering concern, supplying to more than 70 companies throughout the United Kingdom and one customer in France. Categorised as “pure customisation” MTO company, the customer is responsible for the product design and specification while the company is involved in purchasing the materials.

After approximately 20 years of operation, the company achieved a significant milestone when it achieved certification to the British Standard for Quality. The directors had the foresight to recognise that quality would be one of the major hallmarks of the 1990’s, and this resulted in the company becoming one of the

Northwest Region “job shop” to gain accreditation to British Standard 5750 Part 2 and ISO 9002, in 1990.

Four visits were made to this company. The company was visited initially on the 26th of August 1998, then again on the 18th and 19th of January 1999, and finally on the 30th of June 1999. Five people were interviewed including the Managing Director, the Production manager, the Assistant Sales Manager and two shop floor workers. A diagram illustrating the time span between the visits and the level of people interviewed is shown in figure 6.1 below:

Figure 6.1: *Time span between visits and the level of people interviewed at Company A*

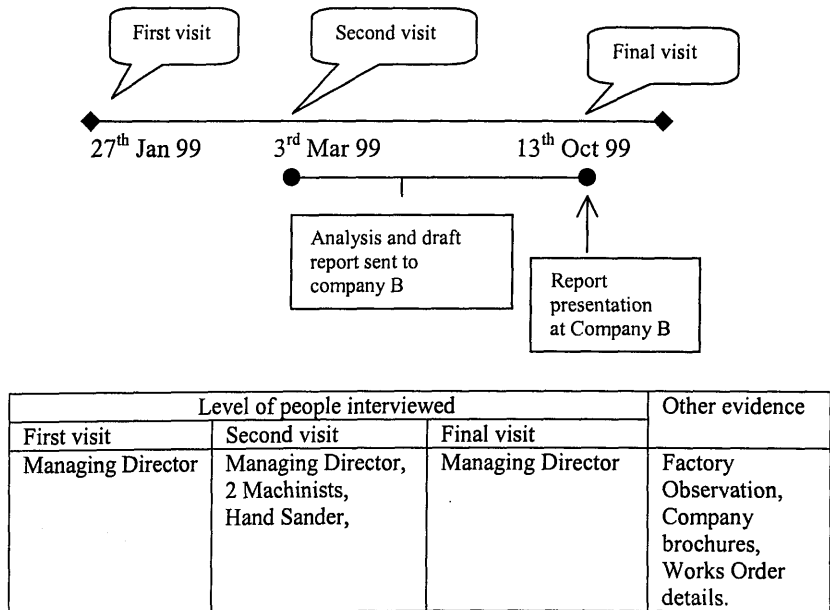


Level of people interviewed				Other evidence
First visit	Second visit	Third visit	Final visit	
Managing Director	Managing Director, Production Manager	2 Turners	Managing Director, Assistant Sales Manager	Factory observation, purchase orders, sales invoices, quotation documents.

6.2. Company B

Company B, employing 16 people, is a privately owned MTO company in the furniture industry. It was established in 1976. Based in Carnforth Lancashire, the company is involved in manufacturing a wide variety of bespoke furniture for home kitchens, bedrooms and shops. The company orders came from two main sources; trade customers/retail and the individual customers. The company has twelve regular trade customers. However, the product is still bespoke furniture, even though the company is supplying to trade/retail customers. This is because all the products are for individual end customers designed for specific kitchens, bedrooms and shops. The Company is considered to be a very small company consisting of £0.25 million of assets and approximately £0.6 million turnover per year.

Figure 6.2: *Time span between visits and the level of people interviewed at Company B*



Three visits were made to this company. The company was visited initially on the 27th of January 1999, then again on the 3rd of March 1999, and finally on the 13th of October 1999. The staff interviewed were the Managing Director and three shop floor workers. A diagram illustrating the research period and the level of people interviewed is shown in figure 6.2.

6.3. Company C

Company C is a ninety-employee firm producing a variety of bespoke bulk silos and feeding equipment for the agricultural industry. Established in 1962 at Preston, Company C has become one of the largest manufacturers of bulk storage silos in the UK, having a turnover of more than four million pounds a year and net assets of £1.5 million.

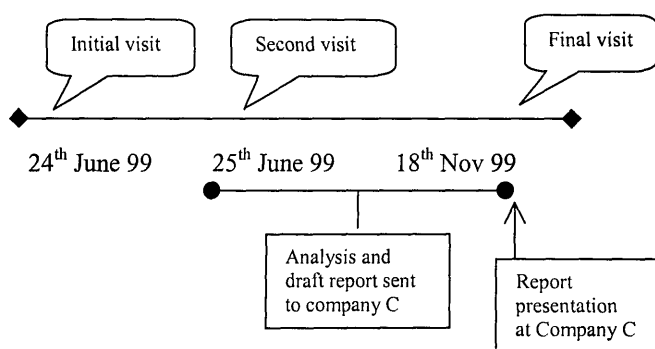
Company C offers silos for a diverse range of materials including bulk powder, plastics, food/feedstuffs, waste products and mineral/chemicals. The company also manufactures a comprehensive range of high quality feeding equipment for cattle and poultry, from simple floor-feeding systems to the sophisticated electronic feeder. Examples are Vector Electronic Sow Feeder, Spin Feeder, Dump Feeder, Opal Feeder and so on.

Eighty percent of the customers are from the UK. Among the customers, 50% are end users and every year the company will have around 2500 end user customers. Another 50% are distributors who act like an agent for the end user customer. Through the distributor, the company is involved in foreign sales to Denmark, Holland, Spain,

Japan and so on, although most of the foreign sales are made to European countries. Foreign sales are limited to “kit form MINI SILOS” only whereby instructions are given for self-assembly by the end users.

Ninety percent of the company’s activity is producing a variety of bespoke SILOS based on different sizes, configurations and finishes. The company is responsible for the product design, specification and purchasing of the materials. For another 10% the customer is responsible for the specification and design while the company is responsible for purchasing the materials.

Figure 6.3: *Time span between visits and the level of people interviewed at Company C*



Level of people interviewed			Other evidence
First visit	Second visit	Final visit	
Marketing Director	Production Director, Operations Director, Personnel Director, 2 Team Leaders, 5 shop floor workers.	Administrative Director, Operations Director	Factory observation, schedule lists, purchase orders, company’s brochures.

Three visits were made to this company. Company C was visited initially on the 24th and 25th June 1999, then again on the 18th November 1999. Eleven people are

interviewed including the Production Director, the Operations Director, the Personnel Director, the Marketing Director, two team leaders and five shop floor workers. A diagram illustrating the research period and the level of people interviewed is shown in figure 6.3.

6.4. Company D

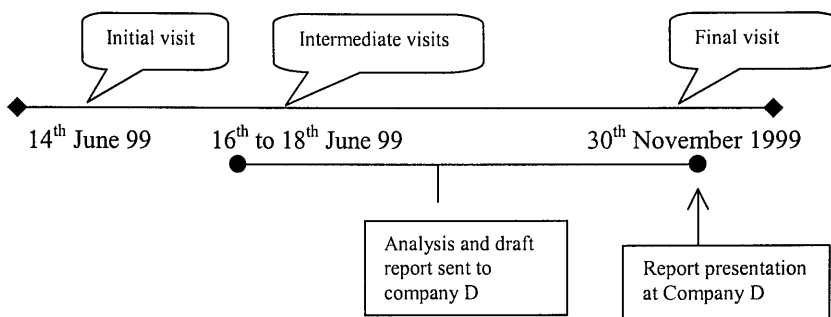
Company D, founded in 1973, is a 140-employee privately owned sheet metal engineering company which operates in Leyland, Preston. Registered as ISO 9002 in 1994, the company aim is to establish itself as a world class co-manufacturer in partnership with its customers. The company philosophy is to provide good quality MTO products backed by a continuing investment in people and high technology. The company is a manufacturer of high precision finished sheet metal components such as telephone brackets and metal casings for boilers.

The company have approximately 100 customers. Among these are 25 regular customers with 10 of them considered as major customers such as PhotoMe, JCB, Ingersoll Rand, Valor and so on. Eighty percent of the company activity is producing a bespoke product based on customer specifications and drawings. The customers provide the design and specification while the company is responsible for purchasing the materials. For another 15% the company makes modification to the customers' drawing while for another 5% it provides a new design.

Three visits were made to this company. Company D was visited initially on the 14th of June 1999, then again on the 16th to 18th June 1999, and finally on the 30th

November 1999. The staff met were the Sales Manager, the Purchasing Officer, the Maintenance Manager, the Quality manager, the Production Manager, the Engineering Manager, the Administrative Secretary and four shop floor workers. A diagram illustrating the research period and the level of people interviewed is shown in figure 6.4 below:

Figure 6.4: *Time span between visits and the level of people interviewed at Company D*



Level of people interviewed			Other evidence
First visit	Second visit	Final visit	
Managing Director, Maintenance Manager.	Managing Director, Sales Manager, Purchasing Officer, Maintenance Manager, Quality Manager, Production Manager, Engineering Manager, Administrative Secretary, 4 shop floor workers.	Managing Director	Factory observation, Newsletter, housekeeping analysis charts, activity charts, quality analysis charts, Best team charts, Pay for suggestions form, Production Control Work-to-Lists, Quality Training Record, Purchase order.

6.5. Company E

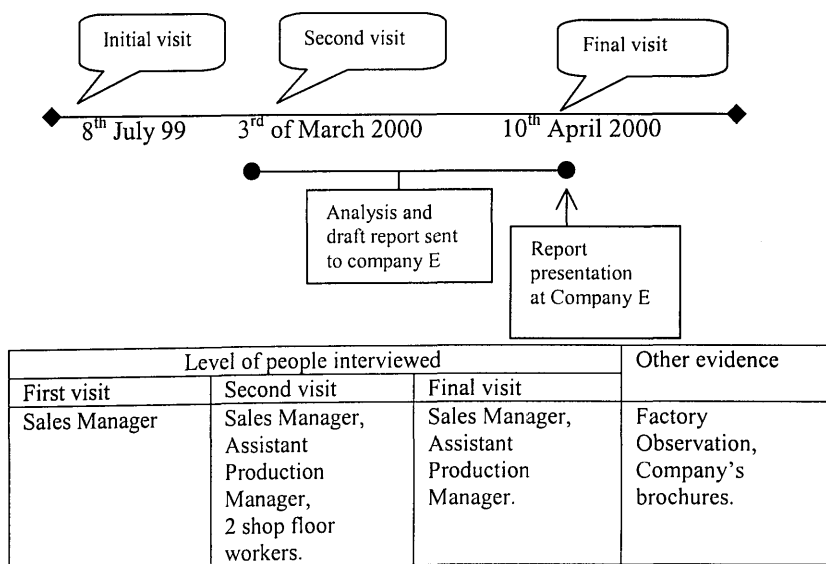
Established in 1970, Company E is a sixty five-employee MTO firm producing a variety of steel shield doors such as escape doors, bullet proof doors, fire proof, sound

proof and so on. The shield doors are made in a wide variety of sizes, configurations, finishings, hardware, door elevations, glazing and structural interfaces.

Ninety percent of the customers are from the UK. The company also has an agent in Hong Kong to market the product in Asia, but the volume is small. With turnover of £4.5 million a year, the company management believes that it is in one of the “top three” market positions compared to its competitors. In 1994, the company achieved the BSI quality assurance recognition ISO 9002 for its steel shield doors product.

Eighty-five percent of the company activity is producing “tailored customisation” products. The customer only provides a basic idea and the company will do all the design, specification and purchasing. The customer must certify the drawing and specifications first before the production starts. For another 10% the company produces a new design while for another 5% it produces standard doors with several sets of design options for customers to choose.

Figure 6.5 *Time span between visits and the level of people interviewed at Company E*



Three visits were made to this company. Company E was visited initially on the 8th July 1999, then again on the 3rd of March 2000, and finally on the 10th April 2000. The staff interviewed were the Sales Manager, the Assistant Production Manager and two shop floor workers. A diagram illustrating the time span between the visits and the level of people interviewed is shown in figure 6.5.

6.6. Company F

Company F with 86 employees is a metalworking based MTO company operating in the Morecambe area, North West of England. Founded in 1960, the company net asset is £1 million and the turnover worth £3 million a year.

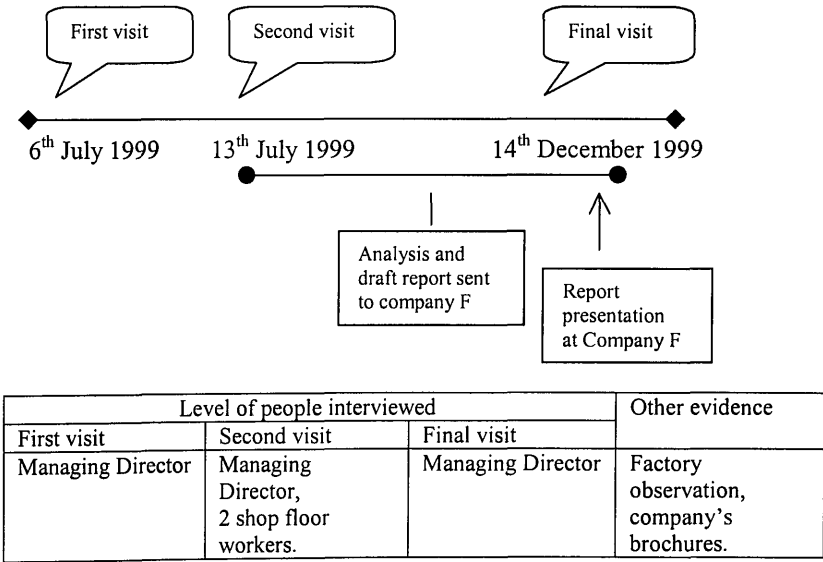
The company is a batch producer of sheet metal and light metal fabrication products in a wide range of materials including mild steel, stainless steel and aluminium. The operations covers the manufacture of sub-contract sheet metal and fabricated components using CNC cutting, punching and press braking technology. The company also offers various processes for product finishing including power-coating (with phosphate pre-treatment), wet painting, plating and polishing. Registered as ISO 9002 in 1997 the company aim is to provide customers with a reliable, quality and cost-effective sheet metal and fabrication service.

The company has approximately 50 customers. Among these are 12 repeat customers, 6 are big and very loyal/regular customers. The other customers might come back maybe every three or six-months or so. Ninety percent of the company activities are

producing products based on customer specification and drawing. The customer provides the design and specification while the company is responsible for purchasing the materials. Five percent of the company activity is producing the new design and another five percent of the company activity is providing a set of standard product or design options for the customer to choose. For example the customer can choose either powder-coating finishing, wet painting/finishing, plating or polishing.

Three visits were made to this company. Company F was visited initially on the 6th July 1999, then again on the 13th July 1999, and finally on the 14th December 1999. The personnel interviewed were the Managing Director and two shop floor workers A diagram illustrating the research period and the level of people interviewed is shown in figure 6.6 below:

Figure 6.6: *Time span between visits and the level of people interviewed at Company F*



6.7. Classification of the companies and the replication logic

Table 6.2 and 6.3 provides a classification of the companies involved in the case study research. As stated in chapter 1, the usage of the MTO label covers many different types of company from ETO1 to MTO5, and so this taxonomy can be a useful way of determining the differences/similarities between the particular companies investigated in this study. Note that in table 6.2, the core activities are used to determine the types of company. For example in company F, the customers may provide 90% of the design and specification while the company provided another 10%. Even though the company provided 10% of the design and specification, this portion is small and the classification of the company types is only based on its major activities.

Table 6.2: *Classification of the MTO Companies based on the Amaro et al. (1999) Taxonomy*

Companies	Customisation			Responsibility for					
	Pure	Tailored	Standard	Design		Specification		Purchasing	
				Customer	Company	Customer	Company	Customer	Company
A	✓			✓		✓			✓
B		✓			✓		✓		✓
C			✓		✓		✓		✓
D	✓			✓		✓			✓
E		✓			✓		✓		✓
F	✓			✓		✓			✓

Companies	Company Activities After Receipt of Order						
	Delivery	Assembly	Processing	Purchasing	Routing	Specification	Design
A	✓	✓	✓	✓	✓		
B	✓	✓	✓	✓	✓	✓	
C	✓	✓	✓	✓			
D	✓	✓	✓	✓	✓		
E	✓	✓	✓	✓	✓	✓	
F	✓	✓	✓	✓	✓		

"The term design refers to the basic idea of the product, often a rough set of drawings. Specifications mean the set of detailed drawings to support production and also the list of both technical requirements and of materials to use. Routings means the definition of the actual path the product will follow in the shop floor: which machines to use in which sequence." (Amaro et al. (1999)).

The six companies involved in the case study research can be classified as follow:

1. *Company A*; Based on information in Table 6.2, the company can be classified as ETO3. It is a VMC because every customer's order is consider as an individual independent buying decision.
2. *Company B*; As shown in Table 6.2, Company B is MTO1. It is categorised as VMC because the company also has to determine a price and a delivery lead-time to quote as an individual bid in response to each customer enquiry.
3. *Company C*; Table 6.2 shows that Company C can be classified as MTO2. Categorised as VMC, every order is consider as an individual independent buying decision and the company needs to compete every time it receives customer order.
4. *Company D*; Based on information in Table 6.2, Company D can be classified as ETO3. Categorised as RBC, the company is involved with a bidding process for a long-term contract with several delivery dates agreed with customers.
5. *Company E*; As shown in Table 6.2, Company D is classified as MTO1. Categorised as both VMC and RBC because the company deals with both markets, individual independent customers and long-term contract supply with its main customers.
6. *Company F*; Table 6.2 shows that Company D can be classified as ETO3. Categorised as RBC, most of the transactions are with 12 regular customers. The

customer will place repeated orders with the company based on the agreement made during an initial purchase decision.

Table 6.3 shows the six types of companies involved in the study. Table 6.3 also shows that the company activities can be divided into two types of market, VMC and RBC.

Table 6.3: *Types of MTO companies*

Classification	ETO2		ETO3		ETO4		MTO1		MTO2	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
VMC			A				B			C
RBC				D&F						
RBC/VMC								E		

6.7.1 The replication logic

It is thought by some authors, such as Yin (1993), that it is important to try to choose case study companies that are expected to give similar results, that is companies that will *replicate* results. Yin (1993) claims that this can prevent subjective bias because the findings are supported by a chain of evidence from different companies and are therefore more convincing. “If such replications are indeed found for several cases, you can have more confidence in the overall results” (Yin 1993).

In this research, similar results were sought by trying to study companies that were considered to be “good” companies. Ideally, WCM companies would have been chosen, but as no WCM definition exists, it is not possible to choose ‘WCM’ companies. Instead, we looked at well established companies, all of which have been

around for more than 20 years, and which have remained similar in size or experienced growth in recent years. These are reasonable indicators that these are “good” companies with forward looking personnel. In addition, all six companies are in the MTO sector and so this should lead to some degree of confirmation of results.

However, as stated earlier, the MTO sector is itself quite complex and it was decided that the research would be too narrow if it concentrated on six companies all in the same group, that is all in one box in Table 6.3. This would not enable the research to explore the question raised in chapter 1, as to whether one model is sufficient to address all the companies in the MTO sector. Therefore, choosing a range of companies, as summarised in Table 6.3, was thought to give enough variety to explore this issue, though of course they in no way represent sampling units of the MTO sector population. In analysing the results, it will be important to determine whether the evidence from one company confirms that from another or conflicts. Where the latter occurs, it will be important to bear in mind the differences i.e. between small and medium, VMC and RBC and so on, as these characteristics may explain any conflicts in the evidence found.

6.8. Conclusion

This chapter has described the six case study companies, explaining that there are two small companies and four medium sized; three are VMC, two are RBC whilst one is a mixture of VMC and RBC; in terms of Amaro’s (1999) classification, three are ETO3, two are MTO1 and one is an MTO2 company. This range of companies was thought to be necessary to explore the issue of whether one model is adequate to

cover the variety of company types within the MTO sector. However, despite the range, it is argued that the replication logic is used in the research in the sense that the companies are all “good” companies and are all in the MTO sector.

In carrying out the research, the two small companies were studied first. The results of these studies are grouped together in the next chapter, Chapter 7, as the results of these two studies were indeed very similar. Chapter 8 then discusses the medium sized companies. It was felt that by grouping the companies in one of the dimensions in which they are different, this would help to highlight any reasons for which conflicting results arise, if indeed there are any conflicts.

CHAPTER 7

CASE STUDY EVIDENCE FROM SMALL SIZED MTO COMPANIES

To further develop the SHEN model, two types of case study evidence were collected:

- evidence related to current practice, and
- opinions from company personnel regarding ideas that are not currently in use in the companies.

It was hoped that where current practice clearly demonstrates the successful implementation of issues within SHEN, this would provide evidence that these issues are of relevance to MTO companies and should be included in the model. Where ideas from SHEN are not currently in use, it was hoped that opinion could be sought to give insights into whether these issues should still be included. Thus, the reasons for not using those ideas were explored. For example, have they been tried and abandoned; have they been considered and dismissed as inappropriate; or does the company consider them to be ideas worth considering for future implementation.

The evidence regarding current practice is presented in the form of a company assessment, which was carried out using the first version of the SHEN model as presented in Chapter 5. This method of analysis ensured that all the issues in SHEN were

covered. Thus, for each company, the level of attainment achieved was determined for each of the principles. Once this analysis was complete, it was possible to list the company strengths from the principles in which the company had attained a level of achievement and to list potential improvement from any issues in the model that had not been achieved. The potential improvements were grouped into short-term, medium-term and long-term changes. The placing of changes into these categories is arbitrary in some cases, but overall, it was intended that short-term issues were the easiest, cheapest changes whereas long-term issues were those that are expected to take a considerable amount of time and/or are more expensive.

Having completed these initial assessments of the companies, these were reported to the management. This stage of the research was firstly used to check that the initial analysis was correct. In some cases, it was discovered that there had been misunderstandings and thus potential improvements should in fact have been strengths and vice versa. Thus this helped to ensure that the evidence of current practice was correct. Secondly, the lists of potential improvements were discussed with the management. This provided the evidence required on issues that are not currently used in the companies.

In this chapter, it is the small companies that are reported on, companies A and B as described in the previous chapter. This chapter is divided into two sections. The first section (section 7.1) describes the case study evidence for company A, and is presented in three parts; an initial assessment for the company, the company response to the initial

assessment, and the final assessment. The second section (section 7.2) contains case study evidence of Company B, which is also discussed in three parts.

It is important to note that it is not possible to present all the definitive ‘evidence’ to support all the assertions regarding the cases presented in this chapter. This evidence exists but space only permits the evidence to be presented in summarised form. The evidence is available in full in the form of ‘transcripts’ which were typed up as part of the transcribing process, after each company visit.

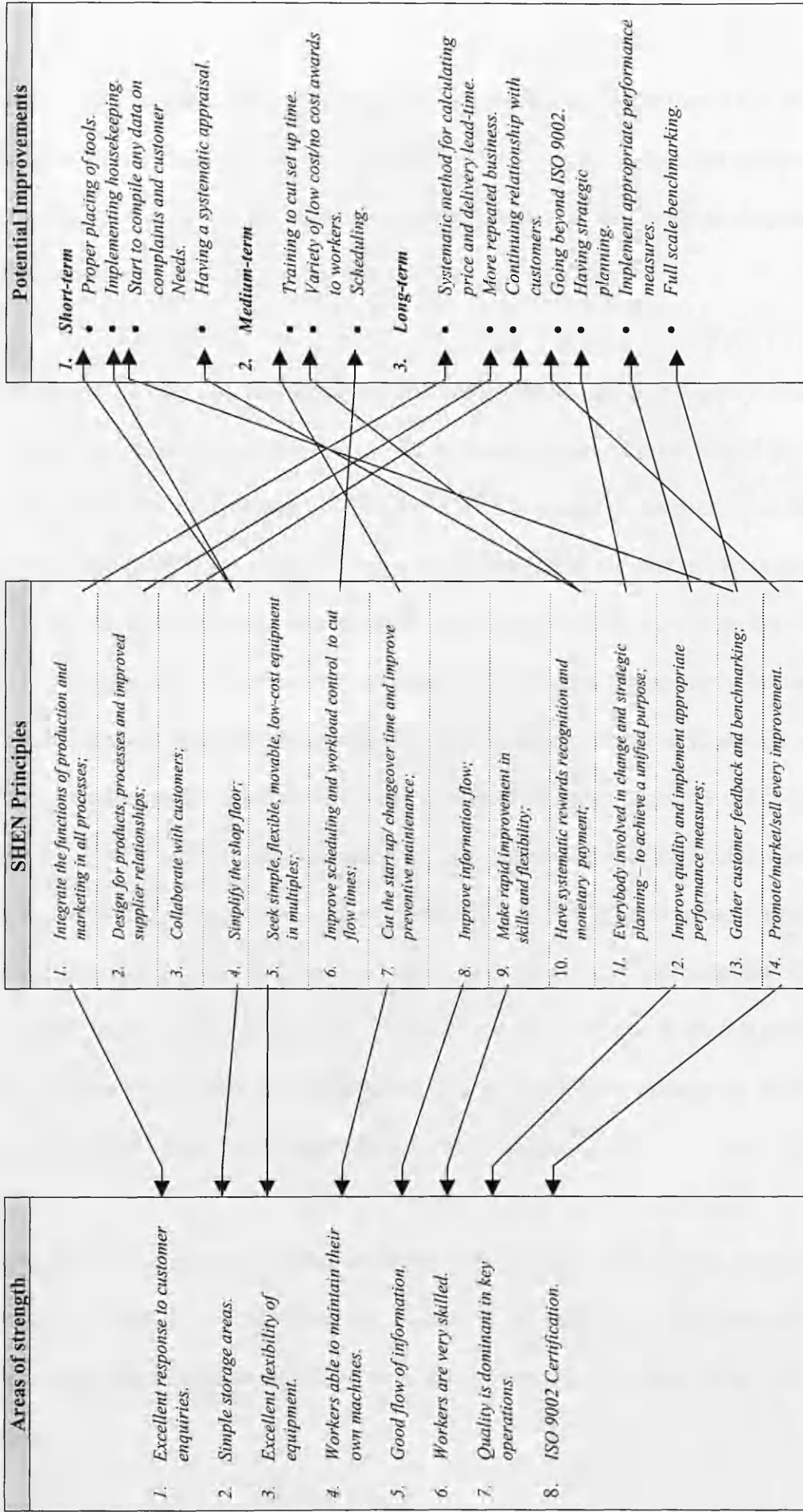
7.1. Case Study A

7.1.1. Initial assessment

The left hand-side of Figure 7.1 shows the areas of strength and the right hand-side shows the areas of potential improvement.

The first strength comes from principle 1, the integration of the production and marketing functions when bidding for customer orders. Due to the small size of the company, both the production and sales departments work on the same floor and communicate several times during the quotation process. Since the production and sales functions integrate well in responding to customer enquiries, ninety-percent of the quotations are done very quickly. It takes one or two hours to figure out these quotations. The MD claimed that if there is a delay, it is because the company is searching for the right kind of raw materials

Figure 7.1: Summary - initial assessment for Company A using the SHEN model.



to include in the quotation. This may require one or more days. After that it will be sent straightaway to the customer by fax. Therefore it was concluded that the company is doing well in principle 1. Hence the first strength listed is an excellent response to customer enquiries as indicated by the first left-hand arrow in Figure 7.1.

The next area of strength as indicated by the second left-hand arrow in Figure 7.1 relates to principle 4, storage issues. The company's finished products are not stored for very long. A product will be dispatched immediately after it has entered the packing area. The storage area is small and very simple. This is because some of the raw materials are not stored in the storage area. When raw materials arrive, they are unloaded from the wagon and will be given a stock number so that they can be placed immediately beside the machine that requires them. However materials such as tubing are placed in storage areas. The storage area is needed because it is more economical to buy a large amount of tubing that can be used at anytime. The company is using approximately £200,000 worth of tubing a year, which is considered a large amount for a small MTO company. However this practice is just the beginning of the world class agenda under principle 4. More improvement is still needed in this area. As illustrated by the arrow in the diagram, the next set of issues identified for improvement are on the proper placing of tools and "housekeeping" which will be discussed later on in the chapter.

The flexibility of equipment referred to in the third strength comes from principle 5, "seek simple, flexible, movable, low cost equipment in multiples". The company has excellent flexibility of equipment. It has more than 15 manual machines, three CNC and

1 NC machine. Manual machines are used most of the time. Except for the CNC, all the machines are small and can be moved around when needed. CNC and NC machines are used to produce a large amount of orders because it is quicker, more reliable and more economical than the manual machines.

The next area of strength is that workers are able to maintain their own machines. This issue has been derived from principle 7, to “cut the startup/changeover time and improve preventive maintenance”. The sixth strength that workers are very skilled is connected to this issue as it is the level of worker expertise that enable them to carry out machine maintenance. They have mastered a range of skills and have the ability to do jobs, which require different machines and different specifications. All the machines are continuously monitored and maintained by the workers. “Everybody is responsible for machine maintenance”, claimed the Production Manager.

The fifth area of strength is derived from principle 8, regarding the information flow. Computerisation is of course of great importance for the company. Much data on employee attendance, personal records, salaries, company purchasing and sales are computerised. This cuts out many internal transactions and lately more than 50% of the office transactions were performed using computers. In terms of “external transactions”, most quotations, drawings and specification are sent through the fax machine. Thus the fifth strength listed is good flow of information.

The sixth area of strength, which comes from principle 9, is on workers skills and flexibility. The workers commonly called Engineers (i.e. Miller Wright, Fitter Turner) are very skilled and expert in their area. Minor breakdowns are not a problem to the company. When the situation arises, the operators can repair their machines by themselves. The Production Manager claimed that the only major breakdown is when there is an electrical fault. The company has then to call a specialised electrician to do the job since it requires certain qualifications. Occasionally, an outside company will also be called if the breakdown has to be repaired immediately. This occurs when the workload is heavy and the machine must be available as soon as possible.

The seventh area of strength which relates to principle 12 is on quality. Everybody in the company is responsible for quality improvement. There is no specific training given to the employees on quality. However, all shop floor members are aware of the significance of having high quality standards in their products. Many products are made on a sequence of different machines so that if an operator passed non-quality work, it would affect the whole production process.

The eighth and final strength relates to principle 14, promote market/sell every improvement. The company gained accreditation to the British Standard 5750 Part 2, ISO 9002, in 1990.

The right-hand side of Figure 7.1 presents an overview of the improvement activities for various time periods: short-term, medium-term and long-term improvements. The first

and second issues under the short-term activities come from principle 4 in the SHEN model; proper placing of tools and implementing the housekeeping concept. Usually a machine has its own tool storage box. And some tools are stored in the tool room. Due to improper placement, time has been wasted searching for the right tools when needed. “Sometimes we have a problem finding tools... We spend time looking for tools”, claimed the turner operator. Therefore it is essential that the tool be placed in good order, properly labelled so that it is easier to find when needed. What is needed is self-discipline among employees. This needs to be developed deliberately by the company. Tidiness is also one of the major concerns that the company needs to improve. There is one cleaner who is responsible for cleaning the office and the shop floor. But the shop floor still looks untidy because there are many leftover small pieces of sheet metal on the shop floor. To improve matters, the company could introduce a “self cleaning” or “housekeeping” concept. Each operator should be given responsibility to maintain the area around his machines in a clean state.

The third issue comes from principle 13, compiling data on customer needs, complaints and satisfaction. The company is constantly in touch with its customers. Any dissatisfaction which occurs is reviewed by the top management. Complaints may be with regard to product delivery, product quality or the price. Product drawings are used to locate any fault of the products. Drawings are stored in the database as well as in file cabinets. A specific number is stamped on the drawing. When complaints occur, the company can use the drawing to trace the faults either to raw materials, delivery or the person who worked on it. “It is important because sometimes customers make complaints

about the parts which turn out to be someone else's fault", claimed the MD. But the company does not gather data formally. "We haven't gathered formal data but constantly get in touch with customers", said the MD. Hence it was concluded that the company should start collecting formal data regarding customer needs, complaints and satisfaction.

The fourth and final short-term issue relates to principle 10, to have systematic appraisal in the company. Acquiring systematic recognition can improve workers' enthusiasm towards work. A supervisor or floor manager can play a role in the process by providing employees with performance feedback related to their job. At present the company does not have a proper means of assessing employee performance.

The first improvement under medium-term activities is with respect to principle 7, training employees to cut the start up/changeover time. Machine set up can take from hours to minutes depending on the type of job. There is no specific training given on this matter. It is based on many years of experience using the machine. When asked about the possibility of reducing the set up time, the only way employees think of achieving this is to combine several jobs together. "Possibly to combine several orders", said the turner. Therefore it was concluded that the company should provide proper training to employees to cut set up and flow-time.

The next issue comes from principle 10 on the variety of low cost/no cost awards to workers. At present there are no bonuses, no incentives and no awards given to the employees. "We think techniques like displaying of photos, monthly recognition and so

on is useless ... [but] we do a few things like inviting them to join us for party”, claimed the MD.

The third and final issue under medium-term improvement is with respect to principle 6, scheduling. In this company, the Production Manager is responsible for scheduling most of the jobs. His main duty is to ensure that the production processes run smoothly. He prioritises and translates orders into a timetable for all employees. He does this based on his experience to determine the jobs that go to the different machines. He knows when to start the job, when to order materials, which machine is suitable, the running time and set up time needed for each job. Relying on one person to do scheduling is too risky because nobody on the shop floor can do the job as well as this person. One possibility is to have a simple computerised scheduling package for the company to assist in the scheduling process. Another possibility is to train other people on scheduling to cover sickness or holidays.

For long-term improvements, the first issue comes from principle 1, a systematic method for calculating price and delivery lead-time. Even though the company does well in this category, all quotations are done manually. The company has very little data on past quotes, in particular very little is known about the unsuccessful bids. This data could be used in marketing strategies for pricing future orders.

The second issue is the amount of the company’s repeat business. This issue is derived from principle 2. At present, the company has a long time established continuing repeat

business with one of the customers. In this particular case, the company may manufacture a similar kind of product for the same customer for the next order. This trend can be seen as an attempt to ensure that the business with that particular customer is going to be continued in the future. Therefore it was concluded that the company should aim for repeat business with other customers too.

The third issue is with respect to principle 3, establishing a persistent relationship with its customer. Having continual relationships with customers can better ensure customer satisfaction, reduce misunderstanding and make the production planning process run more smoothly. Going beyond ISO 9002 certification is the next issue which comes from principle 14, promote/market/sell every improvement. At the moment the company's highest attainment is ISO 9002. Next is having strategic planning, which as referred to in principle 11 relates to the need for future strategic planning for the company. At present the company does not have a clear plan, it is very informal: "Basically we make profit ... the long-term goal is to put ourselves in a position where we are really secure...", claimed the MD. The sixth issue comes from principle 12 and relates to implementing appropriate performance measures. At the moment, company measurement is simply by profit and sales growth. There is nothing on due date adherence, quality standards and so on. Finally, the seventh issue under long-term improvement is benchmarking. At the moment, the company does not perform proper benchmarking. The only comparisons carried out are to ask customers about the prices of the company's competitors.

7.1.2. *The company response to the initial assessment*

To assess whether the above analysis was correct in terms of current practice, and appropriate in terms of suggested changes, a further visit was made to the company. During this stage both the Managing Director (MD) and the Assistant Sales Manager took part in the discussion. The Assistant Sales Manager was called in to get his

Table 7.1: *Company A response to the initial assessment.*

Issues highlighted by case study evidence at the first set of visits.	Company response to the issues raised in the report
<i>STRENGTHS</i>	
Excellent response to customer enquiries.	Agreed.
Simple storage areas.	Agreed.
Excellent flexibility of equipment.	Agreed.
Workers able to maintain their own machines.	Agreed.
Good flow of information.	Agreed.
Workers are very skilled.	Agreed.
Quality is dominant in key operations.	Agreed.
ISO 9002 certification.	Agreed.
<i>SHORT-TERM POTENTIAL IMPROVEMENTS</i>	
Proper placing of tools.	Agreed.
Implementing housekeeping.	Difficult – attitude is hard to change.
Compile data on complaints and customer needs.	Need to compile data on customer needs only, already have the other data.
Systematic performance appraisal.	Disagreed.
<i>MEDIUM-TERM POTENTIAL IMPROVEMENTS</i>	
Training on cut changeover /set up.	Agreed – prefer to do informally (i.e. on-the-job).
Variety of low cost/ no cost awards.	Difficult for a small company.
Scheduling.	Disagreed.
<i>LONG-TERM POTENTIAL IMPROVEMENTS</i>	
Systematic method for calculating price and delivery lead time.	Agreed, but not a company priority.
More repeat business.	Disagreed – need to quote and compete for new orders all the time.

Continuing relationship with customers.	Disagreed. Business is narrow and not many people want the kind of work.
Going beyond ISO 9002.	Not unless driven by the customers.
Having Strategic or operational planning.	OK but available in Director's mind.
	Confidential and not sure it is worth sharing with others
Implement appropriate performance measures	Disagreed- sales growth and profit are preferable.
Full scale benchmarking.	Difficult. Not convinced about this idea.

comments on how to improve the “tooling” system, but wasn’t involved in the rest of the meeting. During discussion, a few areas of controversy were raised regarding the potential improvements as described in this section. However, the MD agreed with the report on the company’s strength as shown in Table 7.1.

Through discussion it was agreed that the keeping of tools in their proper places and tidiness, were the main areas in which the company needed to improve. The Assistant Sales Manager claimed that one of the possibilities to improve these matters is to have enough racking and shelves on which to place the tools. One person could be assigned to label the tools/shelves and be responsible for maintaining the discipline. A tally number could be given to each shop floor worker. When somebody came along asking for a specific tool, the tally number could be taken from him and placed on the rack. This means that other employees would know where the tool was and who had it. The MD agreed with this idea but argued about the cost involved. The company needs to find someone to take care of this matter, the advantage being that this person can also be a toolmaker. He may be responsible for sharpening some of the tools and making tool sets when needed. However, at the time of the visit, the MD was still unsure whether the above idea is worth the cost of the investment required.

Next is the housekeeping issue. The idea of “housekeeping” is reasonable, but the MD claimed that the implementation process is complex. This is because the job design for the shop-floor employees does not currently include any “housekeeping” responsibilities. Assigning “housekeeping” means giving new responsibilities to the employees. Shop floor workers are very busy doing their work. The company also believes that employee attitudes are hard to change at this level. Given these difficulties, the MD was not convinced that this would be successful in this company.

Regarding the systematic performance appraisal issue, the MD claimed that formal appraisal was not helpful because of the small size of the company, and the time needed to monitor performance progress. “... all machinists do the same job. What is expected from them is that they can work at the particular standard that has been set by the company”, claimed the MD. However the company has an informal system (i.e. not a deliberate system). They talk to the shop floor workers and at the same time provide them with performance feedback related to their job. It is also a means for management to search for information on how management can support workers better so that they can be more productive.

Concerning the idea on using customer complaint data, at first it was thought that the company hadn't gathered any formal data on customer complaints. However the company had already done this better than originally thought. Every complaint has been reviewed and corrected and kept on file for future reference. Fortunately the company has

had very few complaints. All complaints are addressed immediately. The company has a management review every 3 months to review all the complaints to search for any common causes to prevent recurrence. In fact, many customers do not inspect the work because they believe that the company is consistently producing quality work. The company has only had four complaints in the last 6 months and the MD does not regard it as a major problem. But the idea on compiling the customer needs data was sustained. This is because the company hasn't got any data regarding customer needs in terms of future product requirements. Customer needs data can be used to track what to do in the near future, for example to produce more rollers, shafts etc.

For the medium-term category, one of the issues is training employees to do machine set up. Nevertheless, training for reducing set up has already been begun by the company through a less formal internal training solution. The key employee is taught individually and then shares his newly gained knowledge with others while on-the-job. What the company is still concerned about is how to produce tools, which will minimise the set up and also minimise the cutting time as well in most machines. "We are intending to produce tools which can work better and faster", claimed the MD. So the company is starting to address the issue of set-up time reduction, recognising that this needs to be achieved for many of the machines. However setting up for CNC machines is not a problem for this company. It is done by the engineering department that links the programmes directly to the CNC machines on the shop floor and the machine operator only needs to insert the specific/correct tools as instructed.

The company is not convinced about the ideas on incentives, rewards and recognition for its employees. “An incentive or award might work in some countries but not in England”, said the MD. He claimed that the workers are all equally skilled and therefore it is quite difficult to assess the performance of the workers, against each other, in addition to which the workers may feel unfairly treated. He believed that workers are likely to think that they are on a par with everyone else and therefore giving any of them rewards and recognition may lead to an unhealthy environment. They all want the same wages increment and tend to work at the same rate, and to the same quality standard as everyone else. The MD also claimed that English people can accept an improvement in wages, but they can’t accept any reduction due to less profit.

Scheduling using software is another issue. The MD was not convinced of the value of using the computer software. “We think that it can be done better by one person, using his mind ...”, said the MD. This means the company relied on the Production Manager’s experience to determine what jobs should be allocated to different machines. Regarding the idea of training people in scheduling, the MD claimed that at the moment the company has two people who can also do this task when needed, although they are not as skilled as the Production Manager.

For the long-term improvement category, one of the issues is to have a systematic method for calculating price and delivery lead-time. The MD agreed with this idea but claimed that it needs more effort and discipline to gather the data, which is not the company

priority. At present the MD believed that his experience is more than enough to handle the enquiries.

The MD did not agree with the idea of more repeat business. In fact, their one long-term repeat relationship reported in section 7.1.1 has recently come to an end as the customer has fallen on hard times. He claimed that this type of business is rather like the “old time pirate ship”; taking opportunities for work as and when they arise. Therefore, the company needs to compete and quote for jobs all the time. Having repeat business is not very easy for this kind of company. In terms of forming continuous relationships with customers, the management claimed that the business is specialised/narrow and not many people want the kind of work that the company does.

Other issues include going beyond ISO 9002 recognition. Due to many constraints such as labour, finance and time, the company is not interested in investing in this kind of activity. Unless driven by its customers, the company doesn't see any point going beyond ISO 9002 recognition.

In terms of strategic planning, initially it was thought that the management wasn't interested in long-term strategy. However it was realised that the MD actually has a strategy in mind concerning machinery, quality and sales. But he is not sure whether it is worth sharing this information with others because of confidentiality.

The next issue is to implement appropriate performance measurements. However, the MD is not interested in the idea because he felt that it is worthless for a company of this size to implement a new kind of performance measurement. “At the moment the measurement is simply by profit and sales growth. We are too small to worry about anything else”, claimed the MD.

Finally the benchmarking issue, the management claimed that benchmarking is very difficult for this kind of business. “ I don’t know how to do it... I quote and I compete”, said the MD. However, as discussed earlier customers are used to compare the company’s price to that of its competitor prices. Usually the company will call the ‘lost’ customers to ask for the quote offered by its competitors. In some cases, the customer may ask for a second quote from the company to lower the price on a par with the price offered by competitors. This happened because the company’s reputation is well known among its customers.

7.1.3. Final assessment

Table 7.2 presents the final assessment for company A, showing which of the five levels specified for each principle in Chapter 5 had been attained and including a summary of comments relevant to that principle.

Table 7.2: *Final assessment for Company A.*

Principles	Levels attained					Comments
	1	2	3	4	5	
Principle 1	✓	✓		✓		<ul style="list-style-type: none"> Integrates well during the enquiry process. Fast response to customer enquiries. Small sized business makes it easier to communicate. Calculation is done manually.
Principle 2	✓		✓			<ul style="list-style-type: none"> Like the “old time pirate”, the company needs to compete and quote all the time. No longer has any repeat business as its principle customer has fallen by hard times. The company is now doing more quoting again than they were.
Principle 3		✓		✓		<ul style="list-style-type: none"> Difficult to form a continuing relationship because the business is specialised, narrow and not many people want the kind of work that the company does.
Principle 4	✓					<ul style="list-style-type: none"> Proper placing of tools and tidiness are the main concerns the company need to improve. Company believes that the housekeeping concept is difficult to initiate because attitudes are hard to change.
Principle 5	✓	✓	✓	✓		<ul style="list-style-type: none"> Most machines are relatively small and simple. Continuously monitored and maintained by the workers.
Principle 6	✓	✓				<ul style="list-style-type: none"> Using personal experience to do scheduling. Graph showing the running time spent on the job was plotted by hand. Suggest using a computer – a computerised Gantt Chart or simple Excel application and not a sophisticated computer system.
Principle 7	✓		✓			<ul style="list-style-type: none"> Training to reduce the set up already in place by the company. The company is concerned about how to produce tools that minimise the set up and cutting time.
Principle 8	✓	✓		✓	✓	<ul style="list-style-type: none"> Everybody understands the concept of job priorities. Planning board to display job packs. Job pack is a list of information that consists of a job number, working instructions, customer reference etc. Many office transactions are computerised. Most external transactions are by fax.
Principle 9	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> Engineers are expertly skilled. Able to do repairs.

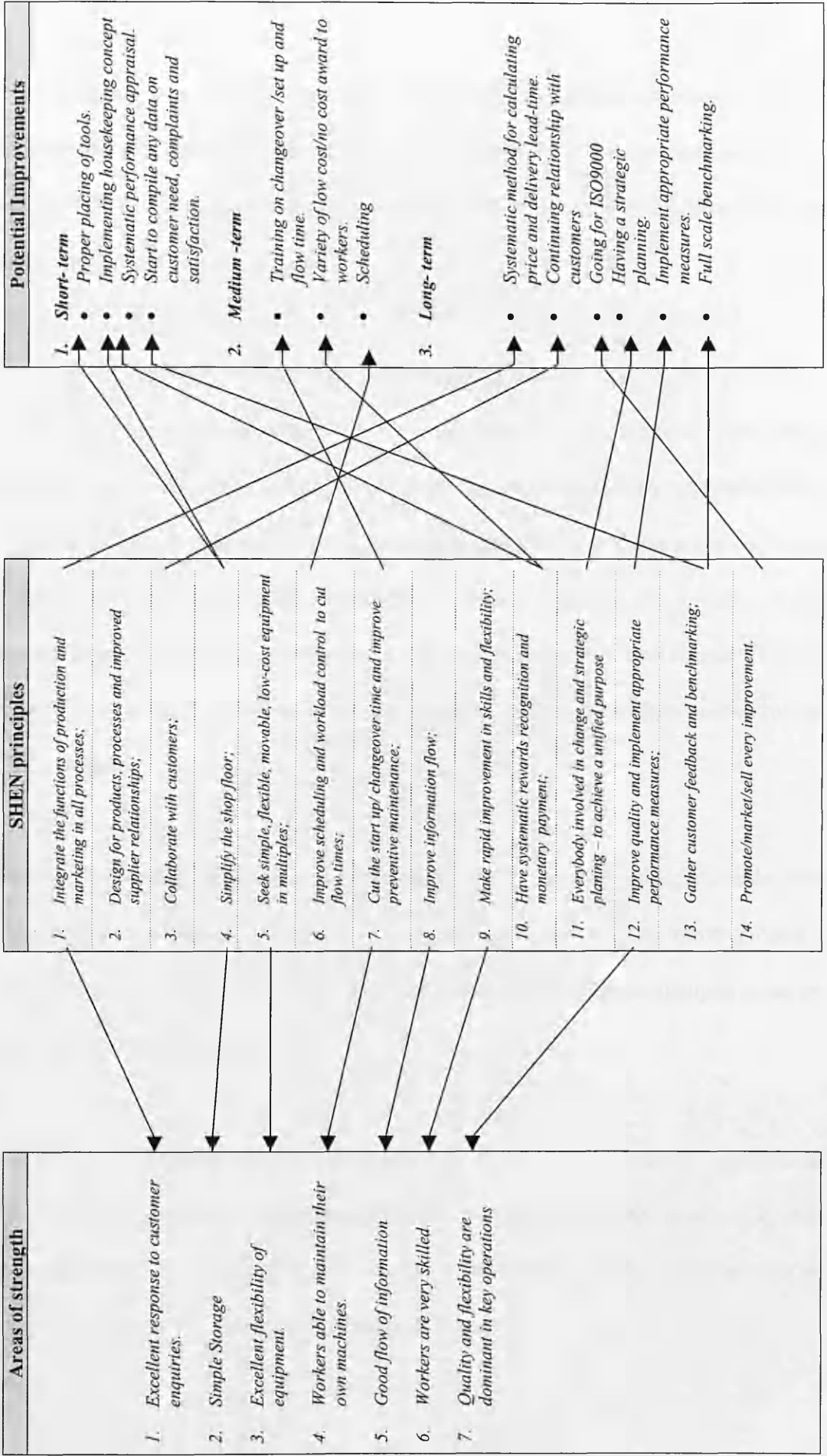
Principle 10						<ul style="list-style-type: none"> • Informal appreciation such as inviting workers to a party; verbal appreciation. • Belief that an incentive or reward scheme does not work in this country. • Assumes that all workers are equally skilled; difficulty in assessing performance which causes unfairness.
Principle 11				✓		<ul style="list-style-type: none"> • The Director feels that he has strategies in mind concerning quality or sales. • Not really formal because of confidentiality. • Encourage suggestions
Principle 12		✓	✓			<ul style="list-style-type: none"> • Shop floor workers know the level of quality needed by customers. • Everybody is responsible for the quality of their products. • Performance measures- sales growth and profit.
Principle 13	✓					<ul style="list-style-type: none"> • Constantly kept in touch with its customers. • Complaints may be in the form of product delivery, product quality or the price. • Every complaint is reviewed and kept in file for future reference.
Principle 14	✓		✓			<ul style="list-style-type: none"> • ISO 9002. • Going beyond this may not be economic unless driven by the customers. • To keep quality high is more important than having quality assessed.

7.2. Case Study B

7.2.1. Initial assessment

The areas of strength are shown on the left-hand side of Figure 7.2. Like Company A, administration, sales and production are located on the same floor. Communication during the enquiry process is therefore very easy and many quotations can be done very quickly. “Usually we respond within 2 to 3 days...if asked we can do it within a couple of hours,” claimed the Managing Director (one of the company’s owners). Window based

Figure 7.2: Summary – initial assessment for Company B using the SHEN model



Excel is used by the company to store information regarding customer enquiries, materials, orders and deliveries. Therefore it was concluded that the company is good on principle 1, “integrate the function of production and marketing in all processes” as shown by the first left arrow in Figure 7.2.

Principle 4, is to “simplify the shop floor”. The company also has a good storage system. They are using a very large amount of timber every year. The storage area is necessary because it is more economical to buy timber from the two suppliers in large quantities. When timber arrives, it is unloaded from the wagon and placed on separate racks based on its code number. Besides timber, “mouldings” are also placed in the storage area on the labelled racks. “Mouldings” are pieces of wood especially made into standard shapes that are regularly needed. All of these raw materials are easy to find when needed by the shop floor workers.

The third area of strength comes from principle 5, “seek simple, flexible, movable, low cost equipment in multiples”. “In general they are small and easy to move around”, claimed the Managing Director. Therefore it was concluded that the company is good on principle 5, flexibility of equipment.

The fourth area of strength is derived from principle 7, to “cut the start up/ changeover time and improve preventive maintenance”. This strength is mainly concerned with machine maintenance. “We don’t have many breakdowns.... The machinist keeps monitoring the machines”, claimed the Managing Director.

The next area of strength comes from principle 8, information flow. Computers are used extensively within the company. It has cut down many internal transactions (administration records, sales, purchasing, etc.) and similarly to Company A, more than 50% of the office transactions are by computer. In terms of external transactions, most correspondence is carried out using e-mail and the fax machine.

The sixth area of strength comes from principle 9, which relates to the fundamental difference between MTO and MTS, the inherent flexibility of the workforce. Skill level and flexibility are already high in this company. In order to give the machinist more proficiency, training on general courses like management, finance and computer handling are given to employees at the North Lancs Training Group, Accrington. Minor breakdowns are not a problem for the company. In fact in 75% of the cases the repairs are done by the workers. However in a major breakdown, the company will call in the machine supplier or an outside company to deal with it.

The seventh and final area of strength is with respect to principle 12, “improve quality and implement appropriate measures”. The Managing Director claimed that the company has had quality implementation in their products for a long time. He claimed that quality is very important and needs to be 100% as far as the customer is concerned, otherwise the company cannot sell anything. The Managing Director also claimed that the employees always know the “value” the customer wants. The customer wants “quality and

flexibility” and the company is providing these values to satisfy its customers. However the company hasn’t got any quality accreditation.

Figure 7.2 presents a summary of the improvement activities for various time periods. The first short-term issue is with respect to principle 4, the placing of tools and the implementation of the “housekeeping” concept. The tooling system is still a problem with this company as time is often wasted searching for the right materials when needed. “It is not only the tools for the machine also the hand tools”, claimed the machinist. Tidiness is the second issue that the company needs to consider. The whole factory looks untidy because small pieces of wood and wood dust are everywhere on the shop floor. There is a janitor responsible for cleaning the areas in the evening but nobody is responsible to clean the shop floor during the day.

The third issue comes from principle 10, to “have systematic rewards recognition and monetary payment”. The company hasn’t done any performance appraisals, although the management claimed that they are constantly monitoring the employees informally.

The fourth and final issue under short-term improvements is derived from principle 13, “gather customer data feedback and benchmarking”. At present, the company hasn’t got any data on customer needs and complaints. Therefore it was concluded that the company should start compiling data regarding customer needs, complaints and satisfaction.

For the medium-term improvements, the first issue comes from principle 7, “training employees to cut set up and flow-time”. The company claimed that they have already achieved a 10 to 20% reduction in the set up time. But the Managing Director argued that this is not enough. He agrees that set up time needs to be improved. “Running time cannot be improved, but we can do it on set-up”, claimed the Managing Director.

Second is principle 10, the issue of rewarding workers. For the time being there have been no bonuses, no recognition and no incentives given to employees. It was concluded that the company should start implementing the reward system to value its employee’s contribution.

The last medium-term issue as derived from principle 6 is scheduling. Only one person is responsible for scheduling the jobs. He prioritises and translates orders into a timetable for all employees. He does this based on his experience in determining which job goes to which machine. But relying on one person to do this scheduling is risky, because during his absence, no other person can do this job as well as he does. Therefore one or more people need to be trained in scheduling. A simple computer package (e.g. Excel) could be used to assist in scheduling because the number of orders is not very large.

Regarding the long-term issues the right-hand side arrows show that there are four potential improvements identified. The first issue is a systematic method for calculating price and delivery lead-time. Even though the company is good in this category, the enquiry/estimation process can still be improved by gathering data on previous bids.

Information on previous bids either won or lost could be used to help the company to evaluate bids better in the future.

The next issue is with respect to principle 3, to have a continuing relationship with its customers. At present the company has appointed a part time agent to deal with customers. His responsibility is to find new sales, make personal contact, and regularly get in touch with customers. He receives commission based on the sales he makes. He is also responsible for compiling any information regarding customer complaints because he deals direct with the customers (i.e. trade customers). Nevertheless this person only works part time. He does not have enough time to do all the work. Therefore the information was not properly gathered. Due to this reason it was concluded that the company should initiate more effort to establish persistent contact with its customer.

The third issue is derived from principle 12, is to go for ISO 9002. At present, the company does not have any accreditation for its product. The fourth issue concerning principle 11 is on strategic planning. The company does not have a proper future plan. When the shop floor workers were asked about the company's plan, nobody could give an answer. "I am not informed about the company's plan.... I don't know", claimed one machinist. The fifth issue relates to principle 12, which is to implement appropriate performance measures. Like company A, the company measurement is simply by profit and sales growth. The final issue which comes from principle 13, is benchmarking. At the moment, the company hasn't performed any benchmarking.

7.2.2. The company response to the initial assessment

For the most part the initial assessment, on the areas of strength and areas for improvement, were agreed by the Managing Director. However, there were a couple of areas of disagreement as shown in the Table 7.3. During this discussion the manager also provided some sample documents including purchasing orders, working schedules, product drawings and the company's finished products. This section will explain the findings of this discussion.

The Managing Director agreed that the workers have to spend time walking around searching for tools. One possibility discussed was for the company to identify specific tools needed in certain areas on the shop floor, and make sure that the tools reside in that place only. The management might then impose a policy to prohibit moving or lending out tools. Another possibility is to purchase more tools so that the time spent searching for tools is reduced.

On the second issue, the company claimed that the idea of "housekeeping" is possible, although there was some debate about how this could be achieved. Initially it was thought that implementation of housekeeping should be based on assigning areas to workers (area centred) but then agreed that it could be achieved by being machine centred. That is, that anybody using the machine should be responsible for cleaning it. The company claimed that assigning the new responsibility to the employees should not be a problem because it is written into the employee's contract.

Table 7.3: *Company B response to the initial assessment.*

Issues highlighted by case study evidence at the first set of visits.	Company response to the issues raised in the report
<i>STRENGTHS</i>	
Excellent response to customer enquiries.	Agreed.
Simple storage.	Agreed.
Excellent flexibility of equipment.	Agreed.
Workers are able to maintain their own machines.	Agreed.
Good flow of information.	Agreed.
Workers are very skilled.	Agreed.
Quality and flexibility are dominant.	Agreed.
<i>SHORT-TERM POTENTIAL IMPROVEMENTS</i>	
Proper placing of tools.	Agreed.
Implementing housekeeping concept.	Agreed.
Systematic performance appraisal.	Disagreed – no prospect of promotion.
Compile data on customer needs, complaints and satisfaction.	Disagreed- time consuming to gather formal data.
<i>MEDIUM-TERM POTENTIAL IMPROVEMENTS</i>	
Training on cut changeover /set up.	Agreed.
Variety of low cost/ no cost awards to workers.	Disagreed – difficult for a small company.
Scheduling.	Agreed.
<i>LONG-TERM POTENTIAL IMPROVEMENTS</i>	
Systematic method for calculating price and delivery lead-time.	Agreed.
Continuing relationship with customers.	Better than initially understood. 90% of the business with regular trade customers.
Going for ISO 9000.	Not unless driven by the customers.
Having strategic planning.	The company performs this but not well documented. Some key personnel are informed.
Implement appropriate performance measures	Disagreed - sales growth and profit are preferable.
Full scale benchmarking.	Agreed would be difficult, but worthwhile.

Regarding systematic performance appraisal, the Managing Director argues that this idea is not suitable for a small company. He believed that formal appraisal is worthless because there is no prospect of promotion. There must be something resulting from formal appraisal. Besides, he felt that assessing people could create fear among workers. The company also hasn't got enough people to handle the formal appraisal task. However, the Managing Director claimed that he was constantly in touch with shop floor people, providing informal feedback on their performance.

The final issue under short-term improvement is on the gathering of data on customer complaints. The company does have regular contact with some main customers. The contact may be in terms of an interchange of ideas on product improvement, or on feedback. The manager agreed that he hasn't got any formal data on customer needs, complaints and satisfaction. The company doesn't intend to gather information using formal approaches because it would be too time consuming.

For medium-term improvements, one of the suggestions is training employees to reduce machine set up. Training for reducing set up is already given by the company through on-the-job training. However the Managing Director agreed that they are still behind in terms of cutting set up time. Through discussion he agreed that having enough tools and keeping them in their proper places could also reduce the set-up time. Another possibility is to buy more sophisticated small machines with a Computer Numerical Control (CNC) set up, which is very fast. It is linked to a computer, and the machine operator only needs to insert the specific/correct tools as instructed by the computer, which will take only a

few minutes. However, as described in Chapter 5, CNC machines are acceptable if the machine is still flexible and movable, but should be questioned if this is not the case. Here, there may be a need to find a balance between the need for faster set-ups and movable machinery.

However the Managing Director does not agree with the second idea on “variety of low cost/no cost awards to workers”. He felt that this idea is difficult to translate into practice. He assumed that the workers are all equally skilled and therefore it is quite difficult to assess the performance of any individual worker, which also may cause unfairness.

In terms of scheduling, the company claimed that they are using Excel to ease the process which is better than initially thought. The company is using backward scheduling from the promised delivery date and a simple Gantt chart to make plans for the jobs. However, the company is still relying on one person to do the scheduling, and the use of EXCEL does not include any capacity planning/workload control.

For long-term improvements, the first issue is on a systematic method for calculating price and delivery lead-time. Though the company is doing well in this category the estimation process could still be improved by gathering data on previous bids. The company agreed that having a systematic method of estimation could be a great help to the company. However the company hasn't got the manpower to gather the data. At the moment, the company does have a part time salesperson who is responsible for marketing

though. His job is to get feedback from customers on price and also to know where the company stands in the market place.

The next issue is concerned with having continuing relationships with its customers. Initially it was believed that 40% of the company business was with regular customers. Nevertheless the company did better than expected. It was found that ninety-percent of the dealings are with regular trade customers. In fact this idea should be included under the company's strengths.

The third issue is going for ISO 9000 recognition. The Managing Director was not interested in going for ISO certification. He felt that accreditation was not important for this kind of business. There were many constraints such as labour, finance and time. Besides the customer did not require it. "We are not interested unless it is driven by customers", claimed the Managing Director.

Regarding strategic planning, the company also did better than initially thought. The manager claimed that the company has a future plan, but it is not well documented. Yet, some key personnel were informed about the company future plan. This includes adopting a new software system, increasing more key people and buying new machinery.

In terms of performance measures the management claimed that turnover and profit were already a good measurement to indicate its company's growth. The management was not interested in other kinds of measurement system (i.e. problem solving, defect rate

reduction) because implementing these kinds of measurements requires an increase in labour time which is a major constraint for a company of its size.

The fifth and final issue is on benchmarking. The management believed that the implementation process is complex because it was difficult to find a suitable company to benchmark with. Like Company A, the main device used by the company is asking the customers to compare prices in relation to its competitor prices. However, the company also sends workers to visit other factories when appropriate opportunities arise.

7.2.3. Final assessment

Table 7.4 summarises the case study evidence for Company B, including an indication of the levels attained for each principle.

Table 7.4: *Final assessment for Company B.*

Principle	Levels attained					Comments
	1	2	3	4	5	
Principle 1	✓	✓	✓	✓		<ul style="list-style-type: none"> • Very good response to customer enquiries. • Small size eases communication. • Window based excel is used to store information.
Principle 2	✓		✓	✓	✓	<ul style="list-style-type: none"> • Company is responsible for design, specification, and purchasing. • Machinists can easily understand the specifications. • As well as new designs, many existing designs are also displayed in the showroom. Customers can pick up any design and decide variations.

Principle 3	✓	✓		✓		<ul style="list-style-type: none"> • Appointed a part time agent to deal with customers. • Higher points may not be appropriate because there are not sufficient employees to have relationships between employees and customers. • Difficult to have customer representatives on the project.
Principle 4	✓					<ul style="list-style-type: none"> • Agreed that issues like proper placing of tools and implementing the housekeeping concept need to be improved. • Discussed the possibility of buying more tools so that no one needs to borrow them and make sure tools reside in one place only. • For housekeeping, it needs to be machine centred and not area centred – therefore the person who used the machine needs to clean it. • Assigning new responsibilities is not a problem – the contract states the workers will do anything the company have written.
Principle 5	✓	✓	✓	✓		<ul style="list-style-type: none"> • Most machines are relatively small and simple and maintained by the workers.
Principle 6	✓	✓	✓			<ul style="list-style-type: none"> • The workload is not high . • Using a simple Gantt Chart – using backward schedule.
Principle 7	✓		✓			<ul style="list-style-type: none"> • No specific training is given to do the machine set-up. • Admit that the company is still behind in cutting set up. • Everybody is responsible for maintenance. • The management agreed that this is the key area for them to make changes. • Several possible alternatives identified to reduce set up – either buying more CNC machines or buy cheaper machines and buy more tooling.
Principle 8	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> • A daily list of working progress is provided using excel printouts – which contain the customer number, order number, customer name and the progress code. Progress code assigned from no. 0-11. 0 is not started and 11 is dispatched. • Many office transactions are computerised. • Most external transactions are by fax. • Currently in the middle of installing new software to link CAD/CAM design directly to the shop floor to shorten the information flow.
Principle 9	✓			✓		<ul style="list-style-type: none"> • Machinists are expertly skilled. • 75% of breakdowns repaired by the machinist.

Principle 10					<ul style="list-style-type: none"> • Verbal appreciation by the Director. • Performance appraisal is worthless because there is no prospect of promotion in small companies. • Assessing people creates fear among workers. • Low cost/no cost award is not worthwhile- workers are equally skilled; unfairness etc.
Principle 11	✓			✓	<ul style="list-style-type: none"> • Encourage suggestions. • The management argues that the company is in trouble if they can't think 5 years ahead.
Principle 12		✓	✓		<ul style="list-style-type: none"> • Shop floor workers know the level of quality needed by customers. • Every body is responsible for the quality of their products. • Performance measures- sales growth and profit.
Principle 13	✓				<ul style="list-style-type: none"> • Does have a regular contact with some key customers. • Interchange of ideas on product improvement and feedback. • Does not intend to gather information in formal ways – informal approach is better with the number of customers they have at present. • But agreed that a more formal approach may be needed as the number of customers grows. • Full scale benchmarking is difficult.
Principle 14	✓				<ul style="list-style-type: none"> • Many sales are due to recommendations. • Selling quality and flexibility. • Unless driven by customers, can't see any point attaining ISO 9002.

7.3. Conclusion

The conclusions drawn from the first two studies show some remarkable similarities, despite very different products and customer bases. It was thought that this might be a result of the similarity in size. For example, both company's management believed that formal appraisal is worthless because there is no prospect of promotion in such a small company. Another example, in terms of performance measures, is that both the company's director stated that turnover and profit were already a good measurement to

indicate their company's growth. They are not interested in other kinds of measurement system because implementing these kinds of measurements requires an increase in labour time, which is a major constraint for a company of this size. These issues may need to be adopted in the final version of SHEN, to reflect small company concerns, depending on whether different evidence is found for medium sized companies.

In addition, there was agreement between Companies A and B on an issue that is not so much to do with company size – the issue of low cost/no cost awards. Both managers interviewed at the final stage were skeptical as they felt that all their workers were equally skilled at their jobs and that assessing the best workers may lead to unfairness. They argued that it is British culture that makes the introduction of recognition/rewards systems difficult. This issue will be considered further in Chapter 9 once the evidence from the medium sized companies has been presented.

However, there were also many differences in the opinions expressed regarding the feasibility of some of the potential improvements. In general, the manager for company B was much more positive. For example, Company A's MD claimed that assigning housekeeping to employees is not possible because workers attitudes are hard to change. This was not expected to be a problem at Company B. Similarly with the issue of benchmarking. Company A's MD was not convinced about the idea of benchmarking but Company B agreed that it was beneficial even though it is difficult to implement. In another area, company A's MD stated that the unpredictable, 'pirate ship' nature of work in the MTO sector is such that there is no point developing long-term strategic plans. But,

Company B illustrated that planning is still possible. The evidence from the medium sized companies, presented in the next chapter, will be of particular importance in shedding further light into these issues of conflict.

CHAPTER 8

CASE STUDY EVIDENCE FROM MEDIUM SIZED MTO COMPANIES

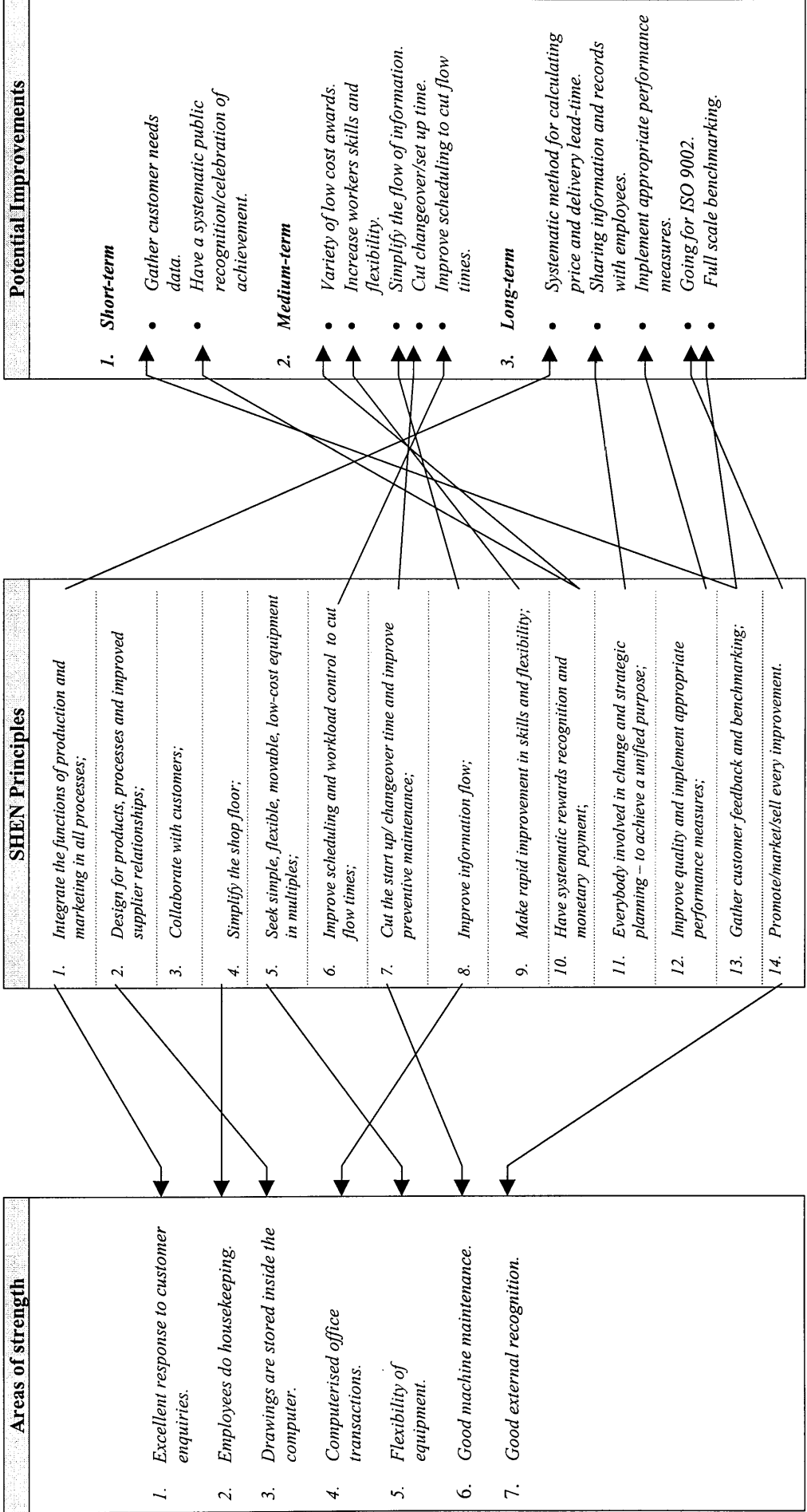
With the same purpose of further developing the SHEN model, the evidence collected from the medium sized MTO companies falls into the same two categories as that collected from the small companies. Thus similarly to Chapter 7, two types of evidence are presented in this chapter: evidence about current practice and opinion on issues not currently undertaken by the companies. To this end, this chapter uses the same structure as Chapter 7, each section being divided into three parts; the initial assessment of the company, the company response to the initial assessment, and the final assessment. Section 8.1 describes case study evidence for company C, Section 8.2 describes company D, Section 8.3 describes company E and finally Section 8.4 relates to company F. Again it is not possible to present all the definitive evidence to support all of the assertions regarding the cases presented in this chapter. However, the evidence is available in full in the form of interview transcripts.

8.1 Case Study C

8.1.1. Initial assessment

Figure 8.1 summarises the initial assessment of the company. Their first area of strength stems from principle 1, concerning the integration of the production and marketing

Figure 8.1: Summary- initial assessment for Company C using the SHEN model



functions. Similarly to companies A and B, the close proximity of the two departments facilitates communication at several points during the quotation process. However there is a key difference in that usually, the enquiry process includes a visit to the customer's site. This is because the agricultural equipment has to be installed within the customer's building. Following the site visit, a detailed CAD drawing is produced to determine the cost. Because the site visit is essential, it will take approximately 10 days to carry out the estimation process. "A shorter time is possible but difficult to achieve because it is a labour intensive process", claimed the Operations Director. To make the estimation process faster, all customer enquiries are registered in the computer database system. This system has been successful in reducing the enquiry time by at least 30% compared to a few years ago.

The second area of strength, the implementation of good housekeeping practices relates to principle 4. In general the factory looks clean and tidy because the shop floor employees do most of the housekeeping jobs. The tooling system is not a problem either, because everybody has been given responsibility to look after their own tools.

The next area of strength, the availability of the computerised drawings that can be used whenever needed, is derived from principle 2. These drawings can be modified based on customer preference such as size, configuration and finishing.

The fourth area of strength, having computerised office transactions to reduce internal transactions is derived from principle 8. The computer is used extensively to store many things such as employee's records, salaries, sales, purchasing, attendance and so on. The

company uses the “SAGE” wages system that is linked to the attendance swipe card machine. The main operating system that the company uses is PEGASUS OPERA. In terms of external transactions, the telephone and fax machine are the most widely used to speed up communication.

The flexibility of equipment referred to in the fifth strength is derived from principle 5 of the model. The company has over 10 different types of large machinery including 2 CNC Turret punches, 2 CNC Benders, Hydraulic Presses, Rollers for rolling sheets, lathes and many other manual machines. Even though these machines are large, they are flexible and can be used to produce many kinds of sheet metal products based on different specifications and designs. “The CNC machines are used most often because they are more accurate and very quick at doing the job”, claimed the Production Manager. It seemed that movable types of machinery are not really important for this company. This is because their production process does not require regular changes in layout.

The sixth area of strength, good machine maintenance, relates to principle 7. Basic maintenance is done by the shop floor workers including greasing, lubrication, machine cleaning and checking the oil levels. They are also responsible for some minor repairs on the smaller machines. Bigger machines like the CNC Turret and CNC Benders are regularly serviced under a contract with AMADA. The company also has its own “Electrical Technician” to do the electronic repairs. This is because “70% of the problems are due to electrical related faults”, claimed the Production Manager.

The seventh and final strength, which relates to principle 14, is on quality certification.

The company recently won some recognition for its products as below:

- *New Innovation Award 1998* – awarded by Pig Farm Magazine for the Electronic Sow-Feeder machines.
- *New Product Award 1998* – awarded by Dairy Farm Magazine for the Mobile Electronic Feeders.
- *Machinery Award 1999* – awarded by Royal Agricultural Society English (RASE) for the Silver, Emerald and Sapphire Electronic Feeders.
- *Farm Efficiency Award 1999* – awarded by Lloyd TSB for the Silver, Emerald and Sapphire Electronic Feeders.

For improvements in the short-term, the first issue, to gather customer-needs data, comes from principle 13. All complaints are reviewed by the top management. Complaints may be in the form of product delivery, product quality or the price. A quality audit form is usually attached to the customer invoice for customers to write comments on. The company's performance is evaluated by a customer questionnaire that has been designed by the company. As an incentive to fill in the form, the customer is told that their name will be placed in a holiday prize draw, if both the questionnaire and payment are returned within a specified time. However, the company hasn't collected the customer-needs data, which is crucial for the company in order to identify and meet customer needs in the future. The second improvement in the short-term, to have systematic public recognition, celebration and achievement is derived from principle 10.

Regarding improvement in the medium-term, the first issue, to have a variety of low cost awards for its workers, is derived from principle 10. “We are not good at rewarding workers but we agree that employees should be rewarded to increase their motivation toward work”, claimed the Personnel Director.

The next issue, to increase workers skills and flexibility, comes from principle 9. Most shop floor workers mastered their jobs through experience and on-the-job training. However, it was found that not many people were multi-skilled. For instance, there are only two workers that can operate the Turret CNC machine. Even the Production Supervisor, who has been with the company for 10 years, can only operates simple machines such as lathes, milling and welding machines, he cannot operate larger machines such as the CNC Turret and CNC Benders. More training is needed in this area, to increase the workers flexibility so that they can be moved around to different machines when needed.

The third issue is from principle 6, to simplify the flow of information. Usually priorities are based on the earliest delivery date. The Production Director manually prepares the “work to lists” and passes them to the shop floor for action. Every time there is a change, everybody on the shop floor needs to erase their list and make changes. However, “too many changes at a time make the job difficult”, claimed the Turret operator. In some cases, the information concerning changes is only passed on by word of mouth. The employees then need to erase and alter the list using liquid paper. This caused many

internal transactions. In some cases, the operators didn't receive the information concerning these changes, and they kept running jobs that were no longer required. Therefore it would be better for the company to start using a simple computerised package such as EXCEL to improve information flow and at the same time reduce internal transactions.

The fourth issue under medium-term improvements, to reduce the start up/changeover time is derived from principle 7. At present the Production Director claimed that it has already achieved a 10-20% improvement compared to the previous set up time. However, a higher level of achievement is still needed in this area.

The fifth and final issue under medium-term improvements, relates to principle 6, scheduling. The decision concerning order priority is usually based on the readiness of the customer's premises to install the equipment. For instance in the Bulk SILOS installation, initially the company has to wait until the customer lays the concrete before installing the equipment. Nevertheless, scheduling is still hand written. Usually the company has a 4-week schedule based on the earliest delivery date (EDD). The further in time, the more uncertain the actual date of installation will be. When change occurs, the company aims to find another job to fill the gap to make sure the delivery vehicle is fully occupied. The company has three fitting teams who can do at least 3 installations per day. At the moment the Production Director uses his personal experience to do the scheduling. It is suggested therefore that the company looks into a more formal computerised scheduling system to suit their daily operations.

For improvements in the long-term the first issue raised is on a systematic method for calculating price and delivery lead-time. The company has a database system that can make estimation faster. However there is little data on past quotes available in the company.

The second long-term improvement to be made, on sharing information and records with employees is derived from principle 11. At the moment all possible information is not shared because some of it is considered confidential. However, it has been suggested that some less confidential issues, such as on defect prevention, rework rates, quality etc., could be shared with the shop floor employees. It is highly likely that in the future, the shop floor employees will be able to use this information to do process analysis and plot trends by themselves.

The third issue, implementing appropriate performance measures relates to principle 12. At the moment the company measures itself by productivity, profit and sales growth.

The next long-term issue, aiming for ISO 9002 relates to principle 14. The company agreed that quality certification is very important. “We are now trying to conform to the ISO 9001 standards and we are applying for that accreditation”, claimed the Personnel Director.

Finally the fifth issue under long-term improvements is on benchmarking. At the moment, similarly to Companies A and B, Company C is only using its customers to find out how competitive its prices are in relation to the price of its competitors.

8.1.2. The company response to the initial assessment.

At this stage, discussions took place with two people in the top-level of management, the Administration Director (the owner's wife) and the Operations Director. Several areas of controversy were raised. This section will explain the findings of this discussion.

For most part, the areas of strength were agreed with the management. However, the ideas on the shop floor "housekeeping" were met with scepticism. It was found that housekeeping was not a "culture", instead it was achieved because the company has one excellent cleaner and the management needed to repeatedly remind workers to tidy up their own areas. This was not felt to be ideal. It was agreed that it would be better if individuals took more responsibility for this.

The first issue under short-term improvements is to gather customer needs data. However the company had already done this better than had been previously understood. "The sales department is responsible for spotting the customer needs", claimed the Operations Director. He argued that, 'quirky' farmers provided many of the ideas about the kind of products needed in the future. These customers were willing to try something new from the company. For example the "spin feeder" was developed based on a

Table 8.1: *Company C response to the initial assessment*

Issues highlighted by case study evidence at the first set of visits.	Company response to the issues raised in the report
<i>STRENGTHS</i>	
Excellent response to customer enquiries. Employees do housekeeping.	Agreed. Employees do housekeeping – not a culture; repeatedly telling workers to tidy up.
Drawings are stored on computer.	Agreed.
Computerised office transactions.	Agreed.
Flexibility of equipment.	Agreed.
Good machine maintenance.	Agreed.
Good external recognition.	Agreed.
<i>SHORT-TERM POTENTIAL IMPROVEMENTS</i>	
Gather customer needs data.	Agreed, although already successful at this in an informal way.
Have a systematic public recognition/celebration of achievement.	Agreed, used to have a newsletter, might start this again.
<i>MEDIUM-TERM POTENTIAL IMPROVEMENTS</i>	
Variety of low cost awards.	Disagreed – rewards can backfire, creating jealousies and an unhealthy environment.
Increase workers skills and flexibility.	Agreed, but product is more standard – it doesn't need much flexibility.
Simplify the flow of information.	Agreed, schedules are still hand written.
Cut changeover/ set up time.	Agreed.
Improve scheduling to cut flow times.	Agreed, – scheduling is currently done by personal experience.
<i>LONG-TERM POTENTIAL IMPROVEMENTS</i>	
Systematic method for calculating price and delivery lead-time.	Agreed.
Sharing information and records with employees.	Disagreed – no reason to tell workers.
Implements appropriate performance measures.	Disagreed - sales growth, productivity and profit are preferable.
Going for ISO 9002.	Achieved ISO 9001 since last visit.
Full scale benchmarking.	Agreed , but difficult.

customer's idea and the company initially produced the product for that particular customer. It took a while for other customers to catch on but once they did, everyone wanted one. However, the company agreed that this area still needed improvement. The

data on customer needs is not always recorded and so some good ideas can be overlooked and forgotten. It was agreed that previous customers could be the best sources of information for the company.

The next issue is on systematic public recognition/celebration of achievement in the workforce. The company had previously published a newsletter four times a year. The purpose of this newsletter was to convey information between the shop floor workers and the management. However, the newsletter was abandoned in May 1999. This was because the management felt that most of the information published was out of date (everybody already knew it), whereas some information was too personal and confidential. Even though it was abandoned, the management agreed that a newsletter could be a good place to publicise its workers' achievements. Therefore the company might reconsider publishing the newsletter again but is still unsure as to whether it is worth investing the time required.

For the medium-term improvements, one of the issues was to reward workers with a variety of low cost awards. The management claimed that once a year the company shows its appreciation of its workers by having a Christmas party. The company also shows appreciation to its workers by sponsoring social activities, for example having a few day trips out and sports event. The company is not convinced by the ideas of performance appraisal or rewarding specific workers. The management felt that rewards could backfire on the company. "Jealousies" among employees could cause an unhealthy environment on the shop floor. For example, overtime was banned in May 2000 but

occasionally one or two critical sections had to work overtime. Some workers saw this as favouritism and “in the same way, a reward system will backfire on us”, said the Operations Director.

The second medium-term issue is about workers skills and flexibility. The management agreed that there are only a few people who could operate CNC Turret machines. However, they claimed that being multi-skilled is not required in some areas. “It is useless to train someone who is not going to use the machine because they won't necessarily get any experience in maintaining their skills”, claimed the Operations Director. However, some workers do have multi-skills and in the discussion it was suggested that this is sufficient to meet the current needs of the business. “So far we have never been without operators”, claimed the Administration Director. However, later on this point was contradicted as it became apparent that the company has begun a “training needs analysis” for all workers including management personnel to identify the areas where they need to train more workers in certain skills. A variety of methods has been planned by the management to increase employee skills further, including in-house training or sending them outside to be trained by the machine suppliers.

The third issue was on information flow. It was agreed that the schedule is hand written, which caused many internal transactions. “We realise that this is a problem but shop floor workers aren't skilled enough to work with the computers yet”, claimed the Operations Director. Therefore, it was agreed that the shop floor workers need to be trained first before the company starts using any computer package.

The fourth medium-term issue was on set-up/changeover time. The company is aware that these times are currently too long. The Operations Director felt that the only way to improve this area was by having better planning so that similar jobs requiring similar tooling, are done one after another. “I think the changeover time will be smooth when you finish one job and then are able to move to the next job without removing all tools from the machines”, said the Operations Director.

Finally the last issue under medium-term improvements was to “cut the flow time and improve scheduling/workload control”. The management agreed that shop floor scheduling and the scheduling of the installation process which is all the responsibility of the company, is currently done using personal experience. The Operations Director claimed that last minute changes occurred because the customer/installer changes the dates for installation but the production planner is not aware of this as soon as is possible. “It seems that something is missing between our salesmen and our installers, which relates to deficient production planning” claimed the Operations Director. A possible solution is to have someone visit the site to check that it is ready for installation at some planned point before the delivery date. If it is not, then the production schedule can be changed accordingly. “It might be worth making this a standard part of someone’s job rather than having that person just trouble-shooting when the site isn’t ready”, said the Operations Director. In terms of product flow time, the Operations Director felt that the time they took between getting the raw materials ready, manufactured and then delivered to final customers was reasonable and no improvement is needed here. In particular, for

installation times, he claimed “If we want, we can decide now and the hopper will be ready on the customer’s site tomorrow afternoon”.

For the long-term improvements category, one of the issues is to have a systematic method for calculating price and delivery lead-time. The company is now searching for software that could help sales to manage enquiries. “Hopefully with the new kind of software, information could be stored electronically such as date of quotation, date visited, types of customers ...”, said the Operations Manager. However, this system is different to a strike rate matrix type approach in which the company needs to gather data on previous bids. Still the company has very little data on past quotes, in particular very little is known about the unsuccessful bids.

The next issue is on sharing information and records with employees. The management is not persuaded that it is wise to give responsibility to the shop floor workers to do process analysis, plot trends or make decisions without supervision. “From our experience, many of the suggestions to cut costs or help the company are considered rubbish”, claimed the Administration Director. That is why the company stopped paying for suggestions.

In terms of performance measures, the management claimed that their existing measurements such as productivity, turnover and profit are already good measures. Therefore, they did not agree that any further measures are needed.

Other issues include going for ISO certification. However, the company has achieved the ISO 9001 recognition since the last visit, and hence this idea is now categorised as a company strength.

Finally, benchmarking is a problem for this company because it is very hard to find a similar kind of company to benchmark against. Rather the company looks inwardly and sees what they are doing wrong. Other than that, the company sends its personnel to attend workshops and talk to other people from other companies. However, it was agreed that this is a worthwhile but difficult concept to pursue.

8.1.3 Final Assessment

Table 8.2 summarises the final assessment for Company C, including a summary of comments made in relation to best practice for each principle.

Table 8.2: *Final assessment for Company C*

Principles	Levels attained					Comments
	1	2	3	4	5	
Principle 1	✓	✓	✓			<ul style="list-style-type: none"> Integrates well during the enquiry process. Enquiries include the visit to the customer's site. Has a database to make estimation faster. Enquiry time has been reduced by more than 30%. Management agreed that there is a room for improvement in terms of a systematic method for calculating price and delivery lead-time. Looking at some software (Microsoft Outlook) to help manage enquiries.

Principle 2	✓	✓	✓			<ul style="list-style-type: none"> • Has a policy to reduce the number of suppliers as low as possible. • Designs and specifications are stored in a database system – can be accessed whenever needed.
Principle 3				✓		<ul style="list-style-type: none"> • Everyone is working towards fulfillment of customer needs.
Principle 4	✓	✓	✓	✓		<ul style="list-style-type: none"> • Few storage areas on the shop floor. • WIP goods are temporarily placed beside the machines. • Factory looks clean. • Workers clean their own areas– but housekeeping is still not a company culture. • Tooling is not a problem.
Principle 5	✓	✓	✓	✓		<ul style="list-style-type: none"> • Equipment is highly flexible and can be used to produce a large variety of products based on different drawings and specifications. • Moving machine around is possible, but not necessary. • Employees do basic maintenance. • CNC machines are serviced regularly under contract agreement.
Principle 6	✓	✓				<ul style="list-style-type: none"> • Production planning determines the order of priority- but the customer decides when he can accept the delivery. • Scheduling is simple and hand written- Liquid paper is used heavily. • The company is aware that proper production planning is needed on the shop floor – a lot of changes are scheduled at the last minute. • Possible solutions include having someone visit the site to check that it is ready for installation at some planned point before the DD. Might be worth making this a standard part of someone’s job rather than having that person just trouble-shooting when the site isn’t ready.
Principle 7	✓		✓			<ul style="list-style-type: none"> • Set-up times have been reduced, but could be reduced further. • Everybody is responsible for basic maintenance. • Bigger machines like CNC machines are serviced regularly under contract agreement.

Principle 8	✓	✓				<ul style="list-style-type: none"> • Everybody understands the job priorities. • Many office transactions are computerised. • Most external transactions are by fax. • Yet scheduling is still hand written; using pen and liquid paper. • The management accept the idea of using the EXCEL package although the shop floor workers aren't familiar with computers and therefore the company needs to expose the shop floor workers to computers.
Principle 9	✓					<ul style="list-style-type: none"> • Operators specialise in their own areas only, though they may have some basic knowledge of other areas. • Some people need more training. • Have a 'training needs analysis'
Principle 10						<ul style="list-style-type: none"> • Previously recognised individual achievement and displayed the recognition in the newsletter – not anymore. • Newsletter was stopped in May 1999 due to perceived redundancy of newsletter and confidentiality. • Agreed that they are not good at recognising and rewarding workers. • Feels that rewards will backfire as "jealousies" can create an unhealthy environment on the shop floor. • But agree that they may start the newsletter again.
Principle 11				✓		<ul style="list-style-type: none"> • Still encouraged suggestions although many suggestions to cut costs or help the company are considered 'rubbish'. • Hasn't got a clear mission statement. The only mission statement is 'Committed To Quality' because the company wants to be seen as a leader in quality.
Principle 12		✓	✓			<ul style="list-style-type: none"> • Every body is responsible for the quality of their own products. • Performance measures – by sales growth, productivity and profit.
Principle 13	✓	✓				<ul style="list-style-type: none"> • A quality audit form is sent to customers with invoices to encourage comments. • Gathers customer satisfaction data. • Gather customer needs data in an informal way.
Principle 14	✓		✓	✓		<ul style="list-style-type: none"> • Good recognition such as New Innovation Awards 1998; New Product Award 1998; Machinery Award 1999; Farm Efficiency Award 1999. • Have gained ISO 9001.

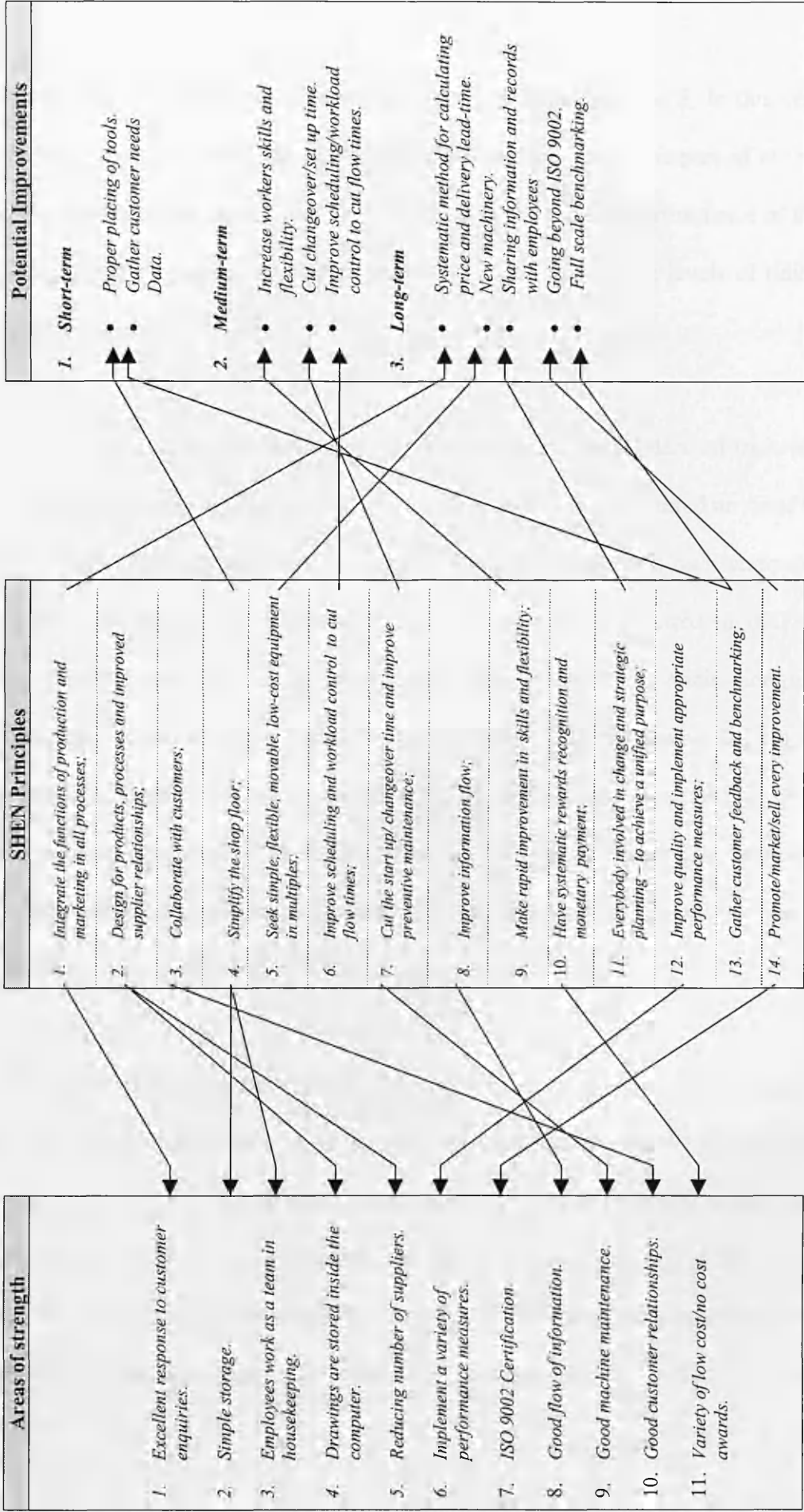
8.2 Case Study D

8.2.1 Initial assessment

As shown in figure 8.2, the first strength is derived from principle 1, “excellent response to customer enquiries”. In this company, the estimation process can take from 1 day to 1 month. It depends on the complexity of the product. A longer time is needed if the product has different drawings or many parts, for example metal casings for boilers, mudguards for a JCB. When customer enquiries arrive, the production and sales departments work together to get the best estimates. Customer enquiries will be registered in the computer system and the customer will be informed if there is additional detail needed for that particular product. Overall, the company has achieved more than a 50% reduction in the customer enquiry response time compared to the last few years. “... we can now quote in a month what might in the past have taken two to three months ...”, claimed the Sales manager.

The second area of strength is regarding the storage issue. The company has three WIP temporary holding areas and three permanent stores; one for new materials and two for finished goods. When the new materials arrive, they are placed on a rack, with the batch number and works order number on it. The work in progress is placed beside the machines waiting to be transferred to the next section.

Figure 8.2: Summary- initial assessment for Company D using the SHEN model



The next area of strength, housekeeping, is derived from principle 5. In this company, shop floor employees work as a team to do the housekeeping. It is part of the workers job. The company has three teams and every month the relative performance of the three teams is displayed on the board. A score sheet is used to rank the levels of tidiness for housekeeping.

The fourth strength, the availability of computerised drawings, is derived from principle 2. Customer drawings are stored inside the computers and can be altered anytime for new orders. Many drawings are imported directly from the customer's own computer. The company CAD system can accept drawings through e-mail converted in DXF format. Some drawings are sent using floppy disk and stored in the main computer for modification. If the company wins the order, this drawing will go to the engineering department through the sales department. If the order is new, the engineering department will produce a new database/program, which then goes to the purchasing department to buy the materials. If the order is repeated, the company can use the information already available in MRP to determine purchase orders and work orders.

The fifth area of strength, the firm's achievement in reducing the number of suppliers, is also derived from principle 2. It is the company's continual aim to cut the number of suppliers. At one time the company had around 300 suppliers but this number has now been reduced to sixty. Among them 20 are considered major and 40 are smaller suppliers. Two of the suppliers STEELCO (UK) Ltd. and Armstrong Steels delivers most of the sheet metal worth nearly £0.5 million. A single supplier is used to supply the nuts

and bolts every month. The company has a stocking policy of having large numbers of nuts and bolts because they are regularly used in the making of sheet metal products. In addition to reducing the number of suppliers, the company has also improved its relationship with some of the suppliers, so that the suppliers now carry more of the risk. This is achieved by the suppliers effectively placing stocks in Company D, but these are only paid for when they are used. Anything that is ultimately not used is not paid for, but is returned to the supplier.

The sixth area of strength, implement a variety of performance measures, comes from principle 12. In some cases, comparisons of performance are made between teams. There are three teams on the shop floor, blue, green and yellow. These teams were established around some of the production processes. The blue team is responsible for guillotining, punching and folding. Yellow is responsible for assembly, paint-powder and paint-wet. Green is responsible for electric welding, spot-welding, mig-welding, tig-welding, hand drilling and grinding. Each team has a team leader, who is given the responsibility to encourage and motivate workers. Every week achievement by the teams is compared and some comparison charts are displayed on the company board. These charts include comparisons of housekeeping achievement, activity analysis (efficiency x utilisation), quality analysis such as reject rates from the batches. Some measurements such as problem solving and sales growth are not displayed but available when requested. Presentations on sales and profit are made later, during a formal meeting together with the announcement of the overall achievement for all other measures.

The next area of strength comes from principle 14, on ISO 9002 recognition. In 1994 the company gained the ISO 9002 award from the Department of Trade and Industry (DTI).

The eighth area of strength is derived from principle 8, and relates to the information flow. The jobs are already prioritised in order by production control. Employees are given a 'work-to' list, which contains the due date, the job number, customer, part number, description, the batch quantity and the minimum requirement. Usually once a week the team leaders receive a new list. Meetings will be held between the team leaders and the shop floor workers to discuss the list contents. The discussions emphasise when to start the job, when the job is going to be completed and when the job is going to be moved to other sections or teams. In terms of internal transactions, most of the company transactions are done using the computer. A database structure for each employee is placed on computer to set the rate of pay, taxes on pay, national insurance and so on. Some records like addresses, phone numbers, training records are also stored on computer. A database is linked to the workers attendance. The employees only need to insert a magnetic stripe card to register attendance, which then links to the payroll system. The system itself calculates the working hours and payment is then based on this calculation. Regarding external transactions, most of the office work is done using the fax machine. Email is mostly used in the engineering section. Many of the customer drawings are sent through e-mail.

Good machine maintenance referred to by the ninth strength comes from principle 7 of the model. Breakdowns are not a problem for this company because it has a maintenance

department to take care of equipment, which is responsible for some minor and major repairs. Bigger machines like the AMADA press brake and the TRUMPF machine are serviced regularly under contract by the machine suppliers. The shop floor workers do the machine cleaning, greasing and checking of the oil level on a weekly basis.

The tenth area of strength is with respect to principle 3, which is to collaborate with customers. The company aim is to establish itself as a world class co-manufacturer in partnership with its customers. Many people are involved in maintaining a good relationship with customers such as the sales, production and engineering departments. Telephone contact is a means of maintaining relationships with its regular customers. To be more involved, sometimes the employees visit the customer to observe the customer's operation, facilities and their product. At present the company has approximately 100 customers. Among these are 25 regular customers with 10 of them considered as major customers such as PhotoMe, JCB, Ingersoll Rand, Valor and so on.

The eleventh and final strength comes from principle 10, on the varieties of low cost and no-cost award. Every month the team performance is evaluated. An award is given for the best team of the month, such as £50.00 to buy new tools for the team. The company also recently published a monthly newsletter as a means of communication, to display the team results and also to convey messages to both employees and management. The company also has a monthly prize draw for fun for everybody on the shop floor. Everybody's name goes in the basket. It is not a reward; but acts in a similar way in that it encourages employees and they seem to appreciate it.

The first issue under short-term improvements, the proper placing of tools, is derived from principle 4. Lack of discipline is the issue here as some workers just leave tools on their table after finishing work and don't return them to the rack. Therefore it is suggested that the tools be placed in proper order with labelling so that they are easier to find when needed. In addition, some tools are poor quality and should be replaced.

The second issue is with respect to principle 13, to gather customer needs data. The company already reviews customer satisfaction. Regular customers like Group Schneider, Photo-Me, JCB, Valor and a few other companies are usually telephoned to get feedback on the products. The information is kept in a file called a log sheet for further analysis. But the company doesn't gather any customer-needs data, which is needed to gain a good understanding of the customer's line of business and their likely needs in the near future. Therefore, it is also suggested that the company start compiling data regarding customer needs.

For medium-term activities, the first improvement issue, skills and flexibility of workers, comes from principle 9. No formal training is given to the shop floor workers. Most of them learned through experience. The company is aware that it is a bit behind in giving proper training to employees and many of them are still low skilled. The training program is not properly structured. Therefore it is suggested that the company continue to train the workers so that they can be moved around to replace other people, when necessary.

The second improvement issue under medium-term activities is from principle 7, to cut the changeover/set up time. “At present the company has already achieved a 10-20% reduction compared to previous set-up times” claimed the Production Manager. However, it is suggested that set-up times are still too long and need to be reduced by a further 10-20%.

The third and final issue is with respect to principle 6, scheduling. This is the only company studied using an MRP system, and although this better than manual system found in Companies A and C, it has not been successful in reducing flow times. This area needs improvement because 4 weeks average flow times are considered very long.

Regarding the long-term potential improvements, the first issue is with respect to principle 1, a systematic method for calculating price and delivery lead-time. Even though the company is good in this category, the enquiry/estimation process can still be improved. Data on sales, successful and unsuccessful bids are important to this company to help price future quotations.

The next issue, to buy new machinery is derived from principle 5. The company has more than 70 machines such as an NC guillotine, a CNC punch machine, a CNC folding machine, press brakes, milling machines, an electronic welding machine, manual machines and so on. Manual machines are still needed to do very specific, small jobs and can be used for pre-production to make prototypes. The machines vary in size. Some are small and some are very big but some of the machines are old and need special care. In

the long-term these machines may not be economical because the cost of maintenance is high. Therefore, it is suggested that the company start doing a “cost analysis” to decide whether new equipment needs to be purchased.

Sharing information and records with employees is the next area of improvement, which is derived from principle 11. The company is already involving employees to some extent by paying for employee suggestions, in a scheme called DYNAMIC. If the suggestions are of value, the person making the suggestion will be paid £5, £10 or £15 depending on the effectiveness of the idea. This idea is part of the company’s continuous improvement strategy. Thus shop floor workers are involved in change and planning in this way. There is also a mission statement around the factory. However, although the company has a strategic plan the shop floor people are not well informed about this. Therefore it is also suggested that all the shop floor employees be informed of the company future plans covering short-term, medium and long-term strategy.

The fourth issue, going beyond ISO 9002 is derived from principle 14 in the model. And finally the last long-term issue, benchmarking is derived from principle 10. Like Company A, B and C, Company D hasn’t done any benchmarking.

8.2.2. The company response to the initial assessment

In general, the MD agreed with the report on the company’s current position. “I won’t disagree with the report. It is very accurate”, said the MD. Table 8.3 summarises the company response to the issues raised in the report.

Table 8.3: *Company D response to the initial assessment*

Issues highlighted by case study evidence at the first set of visits.	Company response to the issues raised in the report
STRENGTHS	
Excellent response to customer enquiries.	Agreed.
Simple Storage.	Agreed.
Employees work as a team in housekeeping.	Agreed.
Drawings are stored on computer.	Agreed.
Reducing the number of suppliers.	Agreed.
Implement variety of performance measures.	Agreed.
ISO 9002 Certification	Agreed.
Good flow of information.	Agreed.
Good machine maintenance.	Agreed.
Good customer relationship.	Agreed.
Variety of low cost/no cost awards.	Agreed.
SHORT-TERM POTENTIAL IMPROVEMENTS	
Proper placing of tools.	Agreed.
Gathering customer needs data.	Agreed.
MEDIUM-TERM POTENTIAL IMPROVEMENTS	
Increase workers skills and flexibility.	Agreed but doesn't think that total flexibility is needed.
Cut changeover/ set up time.	Agreed.
Improve scheduling/ workload control to cut flow times.	Agreed that flow time is long and believed that the MRP system is adequate and they don't need workload control.
LONG-TERM POTENTIAL IMPROVEMENTS	
Systematic method for calculating price and delivery lead-time.	Agreed.
New machinery.	Agree and will update gradually.
Sharing information and records with employees.	Already doing better than previously understood.
Going beyond ISO 9002.	Not convinced unless driven by customer.
Full scale benchmarking.	Agreed – difficult, but worthwhile.

The first issue is on the keeping of tools in their proper place. Without much comment the MD agreed with the suggestion and was willing to give it a try. With regard to the

second issue, to gather customer needs data, the company agreed that this issue needs improving as it is not treating this issue seriously. “The problem is that sales people don’t understand the importance of learning the customers’ needs”, claimed the MD. Even though these people are very busy, the MD is going to make sure that they know about this issue and then make improvement in it.

Regarding the skill and flexibility of workers, the MD still insists that workers should not be given many skills on the shop floor. “Multi-skilling could end up with not having skills in any of the areas”, claimed the MD. This implied that he felt that multi-skilling could lead to a worker being a ‘jack of all trades’, and a ‘master of none’, and that it is preferable for shop floor workers to be specialised. However, he agreed that training is very important in certain areas such as for CNC operators and welders because they do not currently have enough people that can do this work. In fact, the company had already assigned someone in the personnel department to identify the training needs and plan a “training matrix”, to identify who should be encouraged to gain further skills.

Concerning the idea to reduce set up times, the MD agreed that this area could still be improved. During discussions, the MD came up with two possible solutions to reduce the set up time. The first is to remove the setting up allocation from the “work orders”. In this case, the machine operator has to find his own time to do the set up. “The operator will still have the set-up time allocations but it will be incorporated into run time. This will encourage them to think, to set the job quickly, rather than to relax and use all of the time allocation given”, said the MD. This idea will be brought into practice soon. The second

possibility that will be also brought into practice is to encourage more interaction between Production Engineers and the shop floor workers. “The Production Engineer is very familiar with the set up times and its calculation and writes the programs, routing, specifications and so on”, said the MD. So, he might be able to come up with possible ideas/solutions to help machine operators to reduce the set-up times more.

In terms of scheduling, the MD claimed that there is no reason for the company to change from MRP. Although it is not providing a good scheduling solution at the moment, this is perceived to be a result of operator error which can be overcome by better implementation under the watchful eye of the Purchasing Manager. For example “... MRP shows that we have 600 sheets but in reality we haven’t got any”, claimed the MD. Improving the accuracy of the inventory records was therefore thought to be the next step in improving the performance of the MRP system. However, the MD agreed that the average flow times of 4 weeks is quite long and needs to be improved.

For the long-term potential improvements, one of the issues is to have a systematic method for calculating price and delivery lead-time. The MD agreed with the idea but claimed that 90% of the criteria to win the job is down to cost. Categorised as RBC, the company is involved in a bidding process for long-term contracts with several delivery dates agreed with customers. “This means that delivery lead times is not an issue for the company”, claimed the MD. However, the MD agreed that data on prices for previous bids should be properly compiled.

In terms of machinery, the MD agreed that some of the machines are quite old and that some of them need to be updated. The company has a 3-year plan to identify the needs for replacement machinery. “The company may purchase 2 new machines in the year 2001...these machines have a laser facility and cost a quarter of a million each”, said the MD.

Regarding sharing information and records with employees, it was found that the company already did this better than had been concluded from the first stage of analysis. “We have no problem with that... in fact we have published some information in the newsletter and some is displayed on a board”, claimed the MD. In addition, the MD stressed the success of involving workers using their suggestion scheme. In fact, more than £15 is sometimes paid for good suggestions. For instance, the MD claimed that the company had recently paid £150 to three workers who got £50 each for a very simple solution that saved the company an average of £10,000 a year.

The next issue is to aim beyond ISO 9000. The MD does not intend to take up this idea unless it is requested by its customers. He felt that further accreditation is not important, it is “more about gimmick and nothing to do with the product”.

Finally on the benchmarking issue, the MD claimed that it is very hard to find a similar kind of company to benchmark against, but nonetheless he agreed that this issue is worthwhile.

8.2.3. Final assessment

Table 8.4 presents the summary of the case study evidence for Company D, including an indication of the levels attained for each principle.

Table 8.4: *Final assessment for Company D*

Principles	Levels attained					Comments
	1	2	3	4	5	
Principle 1	✓	✓	✓	✓		<ul style="list-style-type: none"> Integrates well during the enquiry process. Has computer software package to quote price. Achieved more than 50% reduction in time to respond to customer enquiries.
Principle 2	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> Customer drawings are stored on computer. Drawings can be imported directly from customer's own computer. Has policy to reduce the number of suppliers as low as possible. Has a system whereby suppliers come in and fill up stock at their cost. The company only pay for the used materials and not for the whole delivery. Has 25 major regular customers – 95% of sales with these 25 customers.
Principle 3	✓	✓		✓		<ul style="list-style-type: none"> Aims to establish itself as a world class co-manufacturer in partnership with its customers. Maintains telephone contact with regular customers. Employees visit customers to observe the customer's operation, facilities, products etc.
Principle 4	✓		✓	✓	✓	<ul style="list-style-type: none"> Few storage areas on shop floor. Factory looks clean. Workers work as a team and take over their own housekeeping. The management agreed to improve the tooling system.
Principle 5	✓	✓				<ul style="list-style-type: none"> Equipment is highly flexible and can be used to produce large varieties of products based on different designs and specifications. Moving around machinery is possible but not needed. CNC machines serviced regularly under contract agreement. However some of the machines are old and need special care.

Principle 6	✓	✓	✓			<ul style="list-style-type: none"> • Production control decides the priority. • MRP system is used for scheduling. • The company agreed that the flow time is long.
Principle 7	✓		✓			<ul style="list-style-type: none"> • Everybody is responsible for basic maintenance. • Bigger machines like CNC are serviced regularly under contract agreement. • Set-up times reduced by 10-20%, but could still be reduced further.
Principle 8	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> • Many office transactions are computerised. • Employees record is linked to workers attendance and automatically calculate the wages. • Email is used extensively in the engineering section to import drawings etc. • Most external transactions are by fax.
Principle 9	✓					<ul style="list-style-type: none"> • Do not intend to make workers too multi- skilled. • Some workers already have basic skill to be able to work in other sections if needed. • Have a 'training matrix' to identify training needs.
Principle 10		✓	✓			<ul style="list-style-type: none"> • No performance appraisal. • Team performance evaluated every month. • Award is given for the best team such as £50 to buy new tools for the team. • Have a newsletter.
Principle 11	✓	✓		✓		<ul style="list-style-type: none"> • Introduced DYNAMIC scheme– paying for suggestions. • Have a mission statement covering the short, medium and long-term. • The company does not have a problem with sharing information with employees.
Principle 12	✓	✓	✓	✓		<ul style="list-style-type: none"> • Every body is responsible for the quality of their products. • The company uses root cause analysis, first order results, sales growth, productivity and profit to measure its performance. • Charts showing team achievement in 3 areas; quality, housekeeping and activity analysis are displayed on the board every month.
Principle 13	✓	✓				<ul style="list-style-type: none"> • Regular customers are rung up to get feedback. • Gather customer satisfaction data. • Agree to gather customer needs data. • Full benchmarking is not carried out at present.
Principle 14	✓	✓	✓			<ul style="list-style-type: none"> • Gain business through phone calls, recommendations, internet, exhibitions. • Have gained ISO 9002

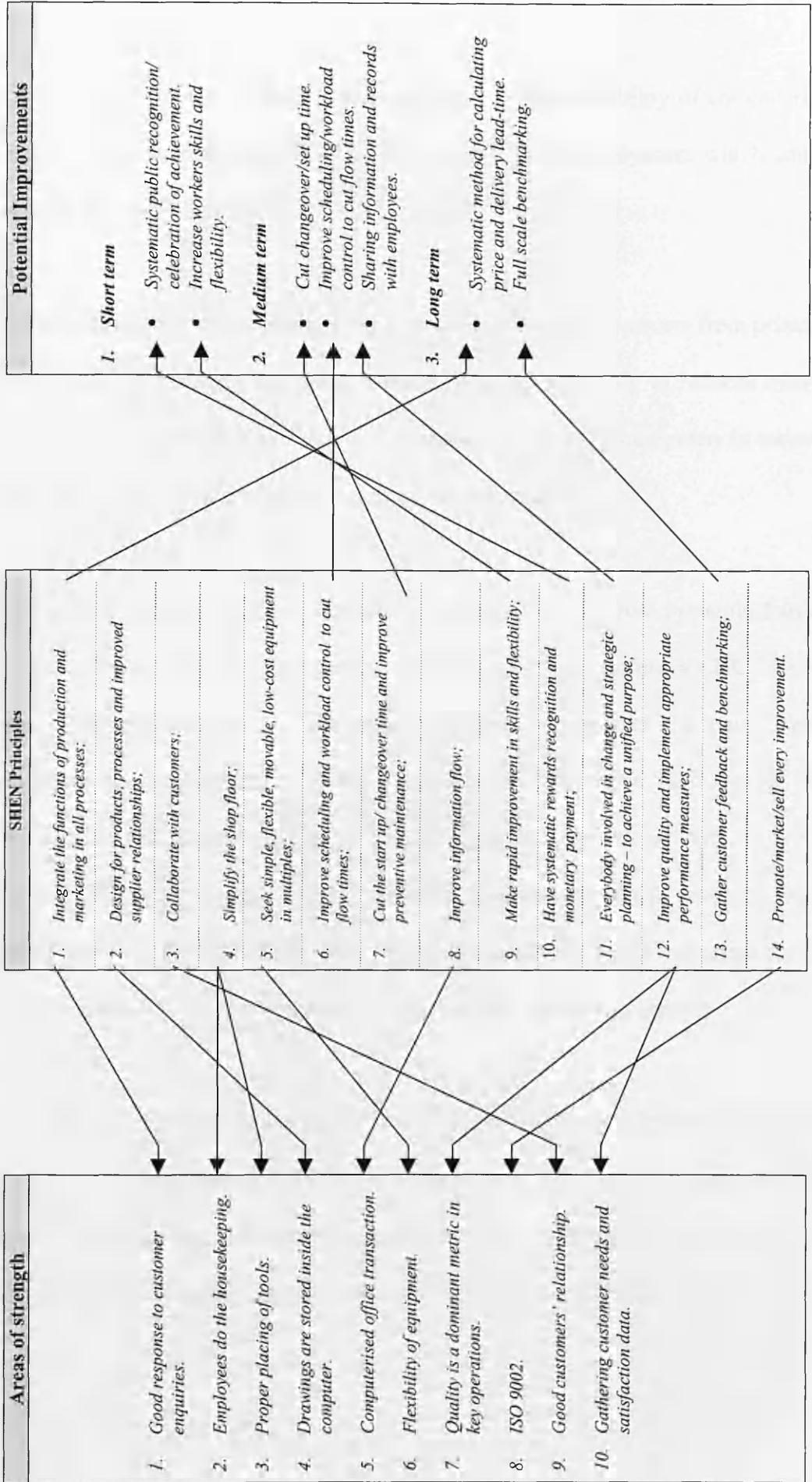
8.3 Case Study E

8.3.1. Initial assessment

As shown in figure 8.3, the first area of strength, good response to customer enquiries, comes from principle 1. When customer enquiries arrive, they go directly to the estimation department for quotation. The estimation department will prioritise the enquiries based on how urgent the customer needs are. Usually the company response time will be between one and seven days. A longer time is needed if the enquiry is very large with hundreds of doors required, for example in a large cinema complex. However if only two or three doors are needed, the quote can be done the same day. Computers are used in the estimation process. “Because of the computerised estimation program ... I would say response time has been improved by at least 50%. Previously so much time was wasted on the enquiries because the process was very labour intensive”, said the Sales Manager.

The next area of strength, employees do the housekeeping, is from principle 4. The shop floor looks very clean. Workers do the housekeeping two or three times a day. They also have to clean and maintain the machines. The third area of strength is also derived from principle 4, regarding the proper placing of tools. Most tools are kept in racks and one person is responsible for their care. In addition, shop floor workers have their own tool kit/box for simple items like pliers, screwdrivers and so on.

Figure 8.3: *Summary – initial assessment for Company E using the SHEN model*



The fourth area of strength is derived from principle 2, the availability of computerised database drawings to do designs. It is a CAD three-dimensional system, which can be used to store and modify drawings.

The computerised office transactions referred to in the fifth strength comes from principle 8 in the model. The computer is used extensively in this company to reduces internal transactions. Information on the “work to list” is also available by computer. In terms of external transactions, most are carried out using the fax machine.

The next area of strength, the flexibility of the equipment comes from principle 5 of the model. The company has nine big machines including a CNC guillotine, a CNC TRUMP machine, a punching machine, 3 CNC press brakes, 2 power presses and many smaller machines. Manual machines are used on a small number of jobs. CNC machines are used most of the time because they are more accurate, quicker and more reliable. However, most machines are flexible and capable of producing a large variety of products. Again like Companies C and D, movable types of machinery are not really important for this company because the production process does not require changes in layout.

The seventh area of strength is derived from principle 12, which is to improve quality and implement appropriate performance measures. Improvement in quality is an important measure in this company. The company uses defect rate, sales growth, productivity and profit to measure its performances. Nevertheless the results are not displayed.

The next area of strength, ISO recognition comes from principle 14 in the model. The company has gained accreditation to British Standard 5750 Part 2 and to ISO 9002, in 1994. In addition, the company has gained recognition from several bodies for the quality of their products including:

- Fire shield – for the perils of smoke and fire, fully tested to the widest field of application in the industry to BS 476 Parts 22 and 31.1 for fire resistance and smoke control.
- Secure shield – for vandal, intruder and terrorist attack; LPCB approved to LPS 1175 issue 2; G1:G2 and S86 ballistic classification to BS 5051.
- Sound shield – for high operational noise levels, comprehensively tested at Salford University to standards of BS 2750 part 3.

The ninth area of strength is from principle 3, collaborating with customers. The company aims to establish a persistent relationship with some of its major customers. The Sales Manager and the Sales Advisor are responsible for establishing these relationships through telephone contact. The company has more than 100 customers and 20 major repeat customers. Examples are Currys, Aldi, Comet, Dixons and PC World.

Finally, the tenth strength, gather customer needs and satisfaction data is derived from principle 13. As part of the company's quality assurance programme, the company provides a twelve months product warranty for its product. The customer is also given an evaluation/feedback sheet when the job is done. The reason is to find out whether the

customer was satisfied or not with the installation services, specification and details of the product. Information collected will be placed on computer. Other information including the customers' current needs and their product designs are also placed inside the computer for future reference. In addition, information to assess potential future customer needs is compiled and stored in the computer. This includes information regarding customers' activity such as leisure, cinema, commercial or shops. In this way the company is able to track what to do in the future, either to concentrate more on enhancing techniques for doors that will be suitable for factory customers, cinemas, offices, bank or shops.

Regarding the short-term improvements as shown in figure 8.3, the first issue is with respect to principle 10, to have a systematic public recognition/celebration of achievement. A proper scheme is needed to appreciate workers achievement maybe in the form of photos displayed on the shop floor or in the newsletter as described in the model.

The second short-term improvement issue, increase workers skills and flexibility is derived from principle 9. Most workers learn through experience and in house training. Generally everybody on the shop floor is flexible and can be moved around if necessary. For example, the puncher operator can go to press brakes, power presses and guillotine if needed. In some cases, the workers are sent to an external organisation to obtain a certain certificate. However, painting jobs require special skills and only certain people can do the job. Therefore the company should train more people in painting so that they can be switched to painting if needed.

Regarding medium-term improvement activities, the first issue is to cut the start up/changeover time. Similarly to other four companies, there is no specific training given on this matter. It is based on many years of experience using the machine. However, more improvement is needed in this area to achieve the company's objective of a 15-minute maximum set-up time. One of the possibilities is to purchase more tools so that machine operators don't need to waste time searching for tools during setting up.

The next area of improvement is on scheduling/workload control to cut flow times. Based on the earliest due date (EDD), the jobs are prioritised by the Sales Manager. This area needs to be improved upon because scheduling is done manually through the Assistant Production Manager's personal experience.

The third and final issue under the medium term improvement, to share information and records with employees, is from principle 11. In order to encourage suggestions, the company pays for the employee suggestions. There is also a mission statement for the company. The company also has a business plan to achieve that strategy. But not many people are informed about this. Therefore it is suggested that all workers should be informed about the company future plan.

For long-term issues, the first improvement activity comes from principle 1, "systematic method for calculating price and delivery lead-time". The company has a customer database record but there is little data available on past quotes especially on the previous bids it has lost.

The next issue under long-term improvement is from principle 13, “full scale benchmarking”. Similarly to the other four companies, Company E doesn’t perform any benchmarking.

8.3.2 The company response to the initial assessment

Table 8.5 summarises the management response to the issues raised in the report indicating agreement with all of the strengths identified. The first improvement is on systematic public recognition/celebration of achievement. The company disagreed with the ideas of rewarding the workers. “Awards may be appreciated or be wonderful for 24 hours ... after that it will be forgotten”, claimed the Sales Manager. He argued that improving the workplace environment is better than rewarding workers. This can make workers feel comfortable at work and at the same time can improve enthusiasm.

The next issue is to “increase workers skills and flexibility”. “I think flexibility already exists because most of the members are capable of switching to another machine”, claimed the Sales Manager. However, the company believes that workers could have too many skills. “Learning without using the machines is wasted because it would soon be forgotten”, claimed the Assistant Production Manager. He also argued that “job rotation” is not good because it can slow down production. In terms of painting jobs, the lack of people skilled in this area is not as problematic as had been concluded from the initial assessment. In fact the Assistant Production Manager claimed that they have enough

people to do painting jobs. There are two people who can do the top coating and five people who can do the prime coating. On a day by day basis, the company only needs one person to do top coating and one person to do prime coating. In fact the company has another worker who can do top coating if necessary, but he is not as quick the regular one.

Table 8.5: *Company E response to the initial assessment*

<i>Issues highlighted by case study evidence at the first set of visits.</i>	<i>Company response to the issues raised in the report</i>
<i>STRENGTHS</i>	
Good response to customer enquiries.	Agreed
Employees do the housekeeping.	Agreed
Proper placing of tools.	Agreed
Drawings are stored inside the computer.	Agreed
Computerised office transactions.	Agreed
Flexibility of equipment.	Agreed
Implement several performance measures.	Agreed
ISO 9002.	Agreed
Good customer's relationship	Agreed
Gathering customer needs data	Agreed
<i>SHORT-TERM POTENTIAL IMPROVEMENTS</i>	
Systematic public recognition/celebration of achievement.	Disagreed – improved workplace is better than rewarding workers.
Increase workers skills and flexibility	Agreed – but doesn't believe in too much multi skilling.
<i>MEDIUM-TERM POTENTIAL IMPROVEMENTS</i>	
Cut changeover/set-up time.	Agreed – aimed at 15-minute maximum set-up time
Improve scheduling to cut flow times.	Agreed to reduce the flow time but computerised scheduling is not needed.
Sharing information and records with employees.	Agreed – some information already shared.
<i>LONG-TERM POTENTIAL IMPROVEMENTS</i>	
Systematic method for calculating price and delivery lead-time	Agreed – already keep records on bids that are won and lost.
Full scale benchmarking	Agreed.

However, the Assistant Production Manager claimed that two more people are needed to operate the folding machines because the company only has one back up person at present. In general these comments confirm the evidence from Companies C and D that multi-skilling for its own sake is not worthwhile. Instead, it is necessary to determine the needs of the company, anticipating changes in requirements, and ensuring that there are sufficient workers skilled in each process.

For medium-term improvements, one of the suggestions is to “cut the start up /changeover time”. The company agreed that this area still needs improvement. “Maybe by having quick release tools and new machinery... set up time can be improved”, said the Assistant Production Manager.

In terms of scheduling the management agreed that scheduling is done by personal experience. The Assistant Production Manager knows which machines need to be used and how long it will take. “ From there I just calculate the [production times] ... say ½ hour on the puncher and ½ hour on the folding machine”, he claimed. He also claimed that a “computerised scheduling package” is not needed in this company. It could be done manually. Furthermore, other people can take over the job if he is not around even though they may not be as good as him. As an aside, it is worth noting that the company has recently introduced a new standard “fastrack” product which is intended to encourage customers to choose standard sizes and colours in order to gain shorter delivery. The Assistant Production Manager agreed that this has complicated the scheduling problem

but still computerised scheduling is not needed. At the moment all “fastrack” jobs take priority. “Fastrack” is only for steel doors, which has limited sizes, limited design and limited colours (6 colours). The customer simply needs to fill in a sheet and decides what he wants from the options given. Usually it will take 7 days to deliver the “fastrack” order. The lead-time for the other jobs, produced according to customer specifications, is much longer – usually between 6 to 8 weeks.

The other issue is to “share information and records with employees”. The company already do this better than originally thought. Recently the management made a full presentation to its workers on what they are going to do in the next 12 months. The Sales Manager claimed that some information is passed through word of mouth and information on sales figures is given out during meetings with employees.

For the long-term category, one of the issues is to have a “systematic method for calculating price and delivery lead-time”. However, the Sales Manager claimed that they have already kept some of records on bids that they won or lost. Recently, the company bought a new computer package system, named “Configurator” by the company, to assist in quotation. “This is because the customer is asking for shorter quotation periods and the management believed that this system could solve the problem”, claimed the Sales Manager. However, at the time of discussion, the package was still not fully operational.

Finally the benchmarking issue, the company claimed that they have practised benchmarking in their own way. “We do practice it ... to get materials at a better price ...

in order to maintain our competitiveness in the industry”, claimed the Sales Manager. The Sales Manager disagreed that benchmarking is costly. “It is an element of time but it is not a high cost”, claimed the Sales Manager. This comment is in contrast to the opinions of many of the other managers interviewed in this research. However, it was felt that the process described above is not really benchmarking. As described in Chapter 4 and 5, the main issues of benchmarking are improving operations, purchasing, services, quality, and reducing the manufacturing lead-time by looking at the methods used by the best companies. It is not about searching for the best materials/quotes from suppliers. In fact all companies do search for the best prices from its suppliers.

8.3.3. Final assessment

Table 8.6 presents the final levels of attainment and a summary of comments for company E based on the case study evidence.

Table 8.6: *Final assessment for Company E*

Principles	Levels attained					Comments
	1	2	3	4	5	
Principle 1	✓	✓	✓	✓		<ul style="list-style-type: none"> Integrates well during the enquiry process. Using a computer to do estimation. Achieved more than 50% reduction in response times for customer enquiries.
Principle 2	✓	✓	✓	✓	✓	<ul style="list-style-type: none"> Customer comes with rough ideas and the company produces the drawings and specifications. CAD system is used to modify and store drawings. Reduced the number of suppliers. Has repeated/contract business with 20 customers.

Principle 3		✓		✓		<ul style="list-style-type: none"> • Maintains telephone contact with regular customers. • Sales Manager and Sales Advisor are responsible for establishing relationships with customers.
Principle 4	✓		✓	✓		<ul style="list-style-type: none"> • Finished products are dispatched immediately. • Housekeeping is part of worker's job. • Tooling is not a problem. • Workers have their own tools box.
Principle 5	✓	✓				<ul style="list-style-type: none"> • Have nine big machines and many smaller machines. • The company inherited old machinery, which is mostly stationary. • Equipment is highly flexible and can be used to produce a large variety of products based on different drawings and specifications.
Principle 6	✓	✓				<ul style="list-style-type: none"> • Sales manager decides the priority. • Work to list is available through the computer. • Practical, simple and easily implemented schedule.
Principle 7	✓	✓	✓	✓		<ul style="list-style-type: none"> • Aiming at a maximum 15 minutes to set-up. The company still wants to improve to achieve this. • Everybody is responsible for basic maintenance. • Bigger machines, like CNC machines, are serviced regularly under contract agreement.
Principle 8	✓	✓	✓	✓		<ul style="list-style-type: none"> • Most people understand the job priorities. • Information on the 'work-to' list is available on the computer. • Most external transactions are by fax.
Principle 9	✓					<ul style="list-style-type: none"> • Many shop floor workers are flexible in skills. • Not many people specialise in painting, but this is not necessary.
Principle 10						<ul style="list-style-type: none"> • No performance appraisal. • The company claimed that an improved workplace environment is better than rewarding worker.
Principle 11	✓	✓		✓		<ul style="list-style-type: none"> • Pays for suggestions. • Have a mission statement and business plan. • Some information is shared.
Principle 12		✓	✓	✓		<ul style="list-style-type: none"> • Shopfloor workers know the quality level needed by customers. • Implements several performance measures.
Principle 13	✓	✓				<ul style="list-style-type: none"> • Customers are asked to return a feedback sheet when the job is done. • Gathers customer needs data.

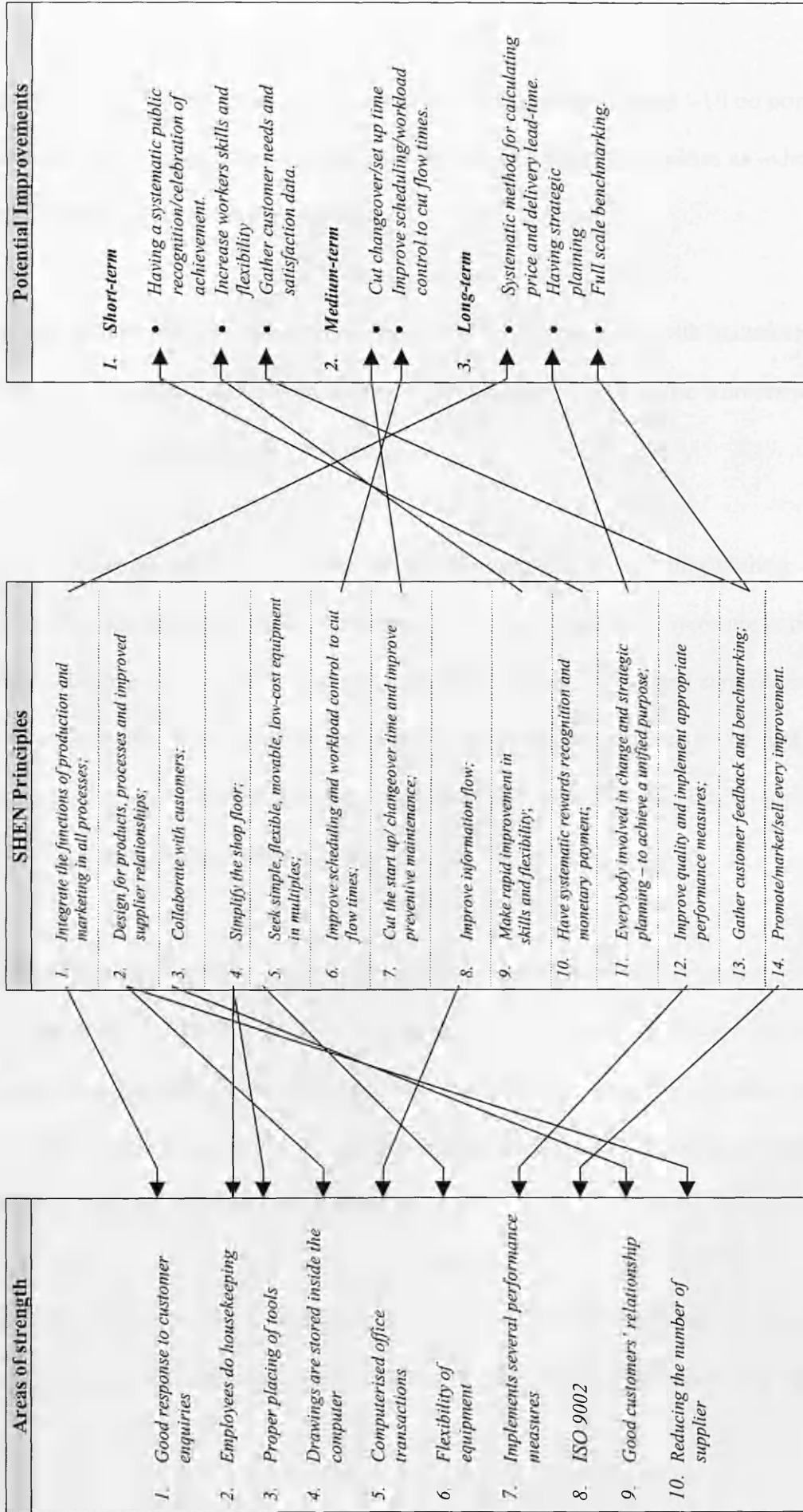
Principle 14	✓	✓	✓	✓	<ul style="list-style-type: none"> • A company called Brain Waves is responsible for advertising. • Have gained ISO 9002 • Have also gained other recognition such as BS 476 Parts 22 and 31.3 for the resistance and smoke control; LPS 1175 issue 2 G1-G2 and S86 ballistic classification to BS 5051; Sound shield standard BS 2750 part 3.
--------------	---	---	---	---	---

8.4 Case Study F

8.4.1 Initial assessment

Figure 8.4 summarises the initial assessment for Company F. Similarly to the other five companies, both production and sales functions work together in responding to customer enquiries. When enquiries arrive, they go directly to the Development Manager, who holds discussions with the customer to confirm and modify the suggested specification. An estimating engineer is responsible for carrying out estimates of cost and processing times. With the help of a computer, standard time, running time, set up time, material cost and so on will be calculated. The time needed to quote depends on the size of the order. Some orders are small and will only take a few days. “But, in some cases a longer time is needed to quote for complete machine, such as a harvesting machine or a customised washing/drying machine, because the production needs to go through various processes such as reviewing, modification, prototype and many others before arriving at a final method of manufacturing”, said the MD. The MD also claimed that the used of computers to do estimates had reduced the enquiry time by at least 50% compared to a

Figure 8.4: Summary- initial assessment for Company F using the SHEN model



few years ago. Therefore it was concluded that the company is doing well on principle 1. Hence the first strength listed is excellent response to customer enquiries as indicated by the first left-hand arrow in Figure 8.4.

The next area of strength relates to principle 4 which is concerned with housekeeping. In general the shop floor looks clean. General housekeeping is part of the workers job, with each employee keeping their own area clean.

The third strength which is also derived from principle 4 is regarding tooling. Usually each worker has his own tool kit, for which he is responsible. Employees are encouraged to have and buy some of their own light tools like hammers, pliers and screwdrivers. The company believes that the employees are more likely to take good care of the tools if they have paid for them. Nevertheless, the company provides some expensive tools while CNC machines have their own special tools.

The next area of strength, customer drawings are stored inside the computers, is derived from principle 2 in the model. Like Companies C and D, some drawings are imported directly from the customer's own computer. The company also has scanning facilities, CAD two dimensional facilities, and three-dimensional CAD facilities to do design. Drawings can be altered anytime if needed.

The fifth area of strength, computerised office transactions relates to principle 8. Computers are used extensively in this company. Some employee records and wages are

kept on computer. All company transactions such as customer orders, purchasing, inventory and invoices are also kept on computer. The company uses email for transmitting data within and outside the company to ease the information flow. In addition, the fax machine is also used to communicate with customers.

The flexibility of equipment referred to by the sixth strength is derived from principle 5 in the model. The company has three CNC Turret Punches, four Press-brakes, 6 presses, three Guillotines and many smaller machines. All of these machines are continuously monitored and maintained by the workers. CNC machines are used most of the time but manually operated machines are still needed to do some specific jobs or for smaller jobs. The machines vary in size. Some are small and some are very big machines. The equipment is highly flexible and can be used to produce a large variety of products based on different drawings, designs and specifications.

The seventh area of strength, implements several performance measures is derived from principle 12. Similarly to Companies D and E the company uses defect rate, rework, sales growth, productivity and profit. However, in contrast to Company D, the results are not displayed.

The eighth area of strength comes from principle 14, and relates to ISO 9002. The company achieved ISO 9002 in 1997. The company view is that ISO 9002 is not only quality recognition but has also opened the door to gain more customers.

The ninth area of strength, good customer relationships, comes from principle 3 in the model. The company maintains a very close relationship with 12 repeat customers, 6 of whom are big and well established customers. For example, the company relationship with “Company Y” (an Agricultural based company) is very close to the point that it is also helping “Company Y” to develop new products. The company relies very much on personal contact using the telephone and occasionally by personal visits. The MD said that he knew his customers individually and in some cases the customers gave him their manufacturing plan for the rest of year. “With commitments to buy specific products, the company may purchase new machinery to do a specific job, if necessary”, claimed the MD.

The tenth and final area of strength comes from principle 2, reducing the number of suppliers. The company policy is to have a single source of component suppliers if possible. For example, sheet metal only comes from a single source since the supplier knows the company’s requirements in detail. Previously, the company had nearly 400 suppliers. Out of those 400, the company is now dealing with 100 suppliers and 50% of the company spending is with 4 or 5 suppliers only.

Regarding short-term improvement activities, the first issue is with respect to principle 10, to have a systematic public recognition/celebration of achievement. The company doesn’t have any bonus or reward scheme but previously the company considered increases in wages as part of the celebration of achievement. Due to a reduction in turnover in recent years, the company has not been able to give increases in wages. Until

it is possible to re-instate this, an alternative lower cost scheme is needed to recognise the workers' achievements.

The next improvement issue, to increase the workers skills and flexibility comes from principle 9. "If the employee is interested, the company will probably sponsor him to learn", said the MD. Nevertheless, not many shop floor workers are multi skilled. Some workers are trained to use specific machines and only a few people can operate the CNC machines. Some welders can operate the manually operated machines but the machinist cannot weld because welding requires special skills. Therefore, it is suggested that the company should train more people in welding so that more people could be moved around when needed. The same thing applies to the CNC machines. More people are needed to operate the CNC machines to cover holidays, sickness and absenteeism.

The third and final issue under the short-term category is to gather customer needs and satisfaction data. There are few complaints but when they do occur they are reviewed immediately. Customer complaints are usually on product quality and delivery. But the company hasn't collected customer-needs data. Therefore, it is also suggested that the company start compiling data regarding customer needs. For example what is the customer's line of business and his likely needs in the future.

For the medium term category, the first issue is to "cut the startup/ changeover time". The MD claimed that the company has achieved 10 to 20% reductions in set-up times but agreed that this area could still be improved.

The next medium-term improvement is to cut the flow time and improve scheduling/workload control. Only two people can decide the priority, the Director and his son the Commercial Manager. Priority is based on the delivery date and the amount of time to be spent on the job. Usually the bigger jobs start first and the smaller jobs are fitted in between. This area needs to be improved upon because scheduling was based on personal experience only. It is proposed that having a computerised scheduling package would be helpful for the company.

For long-term improvement, the first issue is to have a systematic method for calculating price and delivery lead-time. This is because there is little data available on past quotes especially on the unsuccessful bids.

The next issue is to have strategic planning. The company does not have a clear plan, and they are very informal. The company's only objective is to increase turnover and net profit as much as possible. Therefore it is suggested that the company should start implementing a more detailed strategic plan to guide its operation as a whole. It is also suggested that shop floor employees be informed about the company's future plans.

Finally, the third issue is regarding benchmarking which is not currently undertaken by the company.

8.4.2 The company response to the initial assessment

Table 8.7 summarises the management response to the issues raised in the report. A few areas of controversy were raised regarding potential improvements but the MD agreed with the report on the company's strengths. The first issue under the short-term improvements is to have a systematic public recognition/celebration of achievement. However, the MD doesn't believe that incentives encourage people to come to work. Instead job security is the main motivation. "I have been here for 27 years with 4 recessions. And during that period only 10 people were made redundant. During the last recession only 3 people were made redundant but two of them were offered back [their job] before they left", claimed the MD. Other than job security, the MD isn't sure what can motivate workers. When asked about paying for suggestions, the MD claimed that it is very difficult to create this kind of culture in this company. He argued that even the Japanese companies operating in the UK have a problem adopting this kind of culture. "It may work in Japan but it has changed there too. For instance jobs for life have gone", claimed the MD.

Regarding increasing workers skills and flexibility, the MD agreed that the idea is good, but he doesn't believe in total flexibility. He claimed that some basic knowledge is enough to replace absenteeism or holiday leave. Previously the company tried to rotate workers, a few months in welding, a few months in greasing, sawing and painting but this system was only operated for a short period. "After that it actually ended up with people preferring to do what they were capable of doing", claimed the MD.

Table 8.7: *Company F response to the initial assessment*

<i>Issues highlighted by case study evidence at the first set of visits.</i>	<i>Company response to the issues raised in the report</i>
<i>STRENGTHS</i>	
Good response to customer enquiry	Agreed
Employees do housekeeping	Agreed
Proper placing of tools	Agreed
Drawings are stored in the computer	Agreed
Computerised office transactions	Agreed
Flexibility of equipment	Agreed
Implements several performance measures	Agreed
ISO 9002	Agreed
Good customer's relationship	Agreed
Reducing the number of suppliers	Agreed
<i>SHORT-TERM POTENTIAL IMPROVEMENTS</i>	
Having a systematic public recognition/celebration of achievement	Disagreed. Doesn't believe in incentive or bonuses to improve productivity.
Increase workers skills and flexibility	Agreed but doesn't believe in total flexibility
Gather customer needs and satisfaction data	Agreed. The company may start compiling customer needs data. But the problem is the company is very busy.
<i>MEDIUM-TERM POTENTIAL IMPROVEMENTS</i>	
Cut changeover/set-up time	Agreed. Maybe let someone else sharpen the tools.
Improve scheduling/workload control to cut flow times	Agreed. Willing to co-operate if someone can do research in this area.
<i>LONG-TERM POTENTIAL IMPROVEMENTS</i>	
Systematic method for calculating price and delivery lead-time	Agreed.
Having a strategic planning	Agreed but the MD claimed that they haven't got time to do this.
Full scale benchmarking	Agreed but difficult to implement.

In terms of gathering customer needs and satisfaction data, the MD claimed that the company collects the customer complaints data. The company agreed that they must start collecting more customer needs data. The company maintains regular telephone contact

and personal visits with its customers. However, personal visits have been reduced recently and the MD realises that he must spend more time with the company's main customers to identify their needs. "This year only 4 visits were made with my major customer ... this is terrible", said the MD. The reason is that the MD was so busy and couldn't spend time with the customers. "This is so bad because the level I'm dealing with is the board of directors and nobody can represent me", said the MD.

For the medium term category, the first issue is to cut the startup/changeover time. The MD agreed that this area could be improved by purchasing more tools. At present the operator needs to sharpen the tools himself, which means a longer time is needed for set up. The MD claimed that the set up time could be improved by more than 30% if the tools were immediately taken off after the job's finished, put in a special carrier and given to somebody else to sharpen the tools for the next job. "However, it needs more money to buy tools which is quite expensive", claimed the MD.

The next issue is on improving scheduling/ workload control to cut the flow times. The MD believed that there must be a better way to carry out scheduling. The MD argued that he couldn't find any production control system that suited his production environment. He felt that the current software packages available, such as those based on MRP, are not appropriate for this company. "It may work well in assembly operations but not in MTO", claimed the MD. Therefore, he was interested to find out more about the alternative workload control systems being proposed in the model. " We have hardware

facilities, communication facilities and we are looking for somebody who could come in and improve the scheduling”, said the MD.

Regarding long-term activities, the first issue is on a systematic method for calculating price and delivery lead-time. The MD agreed with this idea but the estimator who would need to investigate this further is very busy. The company can’t afford to employ extra people. “... it costs money”, claimed the MD.

In terms of strategic or operational planning, the MD agreed that this issue is quite important. “The problem is that the company is very busy and tends to forget about this”, claimed the MD. When asked about sharing some information with employees, the MD claimed that he likes to communicate with employees on a regular basis, when time permits. The company began to have a newsletter, initially produced by the MD. However, due to time pressures this task was delegated to another member of staff and eventually it ceased to be produced. “This man cannot be blamed because he was also very busy”, said the MD.

Finally the third long-term issue is with respect to benchmarking. The company agreed that it hasn’t done any benchmarking. “But I’ve no doubt that benchmarking is useful”, claimed the MD.

8.4.3 Final assessment

Table 8.8 summarises the current levels of practice/attainment for company F, including a summary of comments relevant to that principle.

Table 8.8: *Final assessment for Company F*

Principles	Levels attained					Comments by the M.D
	1	2	3	4	5	
Principle 1	✓	✓	✓	✓		<ul style="list-style-type: none"> Integrates well during the enquiry process. Using a computer to do estimates. Achieved more than a 50% reduction in response times for customer enquiries.
Principle 2	✓		✓	✓	✓	<ul style="list-style-type: none"> Customer comes with design and specification. CAD system used to store and modify drawings. Aims for a single source of component supplier. Most transactions are with the regular repeat customers. Achieved more than 50% repeat business
Principle 3		✓		✓	✓	<ul style="list-style-type: none"> Rely very much on personal contact and personal visits. Knows all his customers individually. Some customers gave their plan for the rest of the year. Helping customers to develop new products. Customer is treated as a 'partner'.
Principle 4	✓		✓	✓		<ul style="list-style-type: none"> Few storage areas on the shop floor. WIP is temporarily placed beside the machines. Housekeeping is part of each worker's job. Good tooling system. Employees are encouraged to buy their own light tools.
Principle 5	✓	✓	✓	✓		<ul style="list-style-type: none"> Equipment is highly flexible and can be used to produce a large variety of products based on different drawings and specifications.
Principle 6	✓	✓				<ul style="list-style-type: none"> Only the Director and the Commercial Manager can decide on priority. Spreadsheet list called 'hit list' with delivery dates is available on the shopfloor.
Principle 7	✓		✓			<ul style="list-style-type: none"> Everybody is responsible for basic maintenance. CNC machines are serviced regularly under contract agreement.

Principle 8	✓	✓		✓		<ul style="list-style-type: none"> • Employees' records and wages are kept on computer but calculation is done manually. • Most external transactions are done by fax. • Many office transactions are computerised.
Principle 9	✓					<ul style="list-style-type: none"> • Workers are considered multi skilled in this company if they can do two jobs or operate more than one machine.
Principle 10						<ul style="list-style-type: none"> • No performance appraisal. • No rewards scheme. • Doesn't believe in incentive or bonuses to improve productivity.
Principle 11	✓			✓		<ul style="list-style-type: none"> • Encourage suggestions.
Principle 12		✓	✓	✓		<ul style="list-style-type: none"> • Shopfloor workers know the quality level needed by the customer. • Implements several performance measures.
Principle 13	✓	✓				<ul style="list-style-type: none"> • Constantly get in touch with customers through personal contact. • Gather customer satisfaction data.
Principle 14	✓	✓	✓			<ul style="list-style-type: none"> • WWW page for advertising. • Have gained ISO 9002.

8.4. Conclusion

For many of the issues discussed with the management, there were similar conclusions for all four of the medium sized companies. For example, both benchmarking and systems for determining the price and delivery to quote during the competitive bidding process are not undertaken in any of the four companies at present, but the management agreed that these issues should be addressed. However, in some cases there has been some conflicting evidence. These include performance measurement, workers recognition/awards, sharing information with employees, the success of suggestion schemes and so on. For example, three companies D, E and F agree that performance measures such as root-cause analysis and first order results are worthwhile. However, Company C was not convinced with this idea and still prefers to use turnover and profit

to indicate growth. The next chapter will explore the reasons for conflicts of this type indicating how the SHEN model has been adjusted based on the evidence above and the evidence from Chapter 7.

CHAPTER 9

ADJUSTING THE SHEN MODEL IN THE LIGHT OF THE CASE STUDY EVIDENCE

This chapter discusses each of the fourteen principles of SHEN in the light of the case study evidence presented in Chapters 7 and 8. For each principle, the evidence is analysed illustrating whether and why the original model is appropriate to the MTO sector. For some principles, it was concluded that no changes were required. These principles are grouped together in section 9.1. For others, it was concluded that the issues were appropriate but that the order/rank of the 5 steps needed changing, as described in section 9.2. There were also some principles, which were felt to need modification and these are grouped together in section 9.3. In other areas, it was concluded that some principles need to be merged and these issues are described in section 9.4. Lastly, there was one principle that was dropped and this is described in section 9.5. Finally, section 9.6 provides a summary table of the modified version of the SHEN model, the final version presented in this thesis.

Some of the case study evidence is summarised in tabular format in Appendix 2. This appendix is included as a useful '*aide memoire*' regarding the current practice in the six case studies.

9.1. Issues that were verified.

9.1.1. Principle 1: Integrate the functions of production and marketing in all processes.

As stated in Chapter 5, this issue has been recognised as one of the important issues in the MTO sector. All the six companies' management agreed that the production and marketing departments should have a good understanding of each other's aims and work together to respond to customer enquiries as stated in levels one and two of this principle. Five companies agreed that a computer software package was beneficial in assisting in the quotation process as required by the third level. To achieve the fourth point level, a 50% reduction in estimation time to respond to customer enquiries is required. The target of 50% seems realistic because four companies, B, D, E and F illustrated that when the database is properly in place the response time can be reduced by more than 50%. However, one company, Company A, prefers to use manual calculations even though the MD agreed that computer software is better. The MD felt that at the moment his personal experience was more than enough since the number of orders being dealt with was small.

Even though all the six companies are good in this category, the enquiry/estimation process can still be improved as none of the companies have achieved step 5. As stated in Table 5.3, the highest step in this principle requires the companies to have a systematic method for calculating price and delivery lead time. During discussion all the six

companies' management agreed that the enquiry/estimation process could still be improved by gathering data on previous bids.

Therefore the initial version of this principle has not been changed because the case study evidence suggested that the five levels of improvement in the initial SHEN model are relevant to MTO companies.

9.1.2. Principle 13: Gather customer feedback and benchmarking.

All the six companies management agreed that collecting customer satisfaction data is important to the companies. The management of Company A claimed that they collect customer-satisfaction data even though it is difficult due to time constraints. Company B, on the other hand does not intend to gather information in formal ways because they felt that an informal approach is better with the number of customers they have at present. But the management agreed that a formal approach could be used as the number of customers grows because the data will be more reliable with better facts and figures. Company C, as described earlier in Chapter 8, collects data in a more interesting way. A quality audit form was attached with invoices for the customer to put comments on. As an incentive, the customer's individual name will be placed in a prize draw entry for a holiday, if both the questionnaires and payment are returned within a certain time.

Four companies, C, D, E and F collect customer's needs data, in addition to customer's satisfaction data. However, the management of Company A argues that customer needs

data is unlikely to be useful for VMCs of its type, which have no product line and no repeat customers. Given that Company C, also a VMC, has successfully made use of such data, it was decided that this issue is worth keeping in the model. As described in Chapter 8, the 'spin feeder' for company C was developed based on a customer's idea. It is the customers/farmers who provided many of the ideas to this company about the kind of products needed in the future.

In terms of benchmarking, the evidence from all the six companies suggests that this could be beneficial but extremely difficult, thus none of them were actively involved in this at present. For example, all companies' management suggested that it is difficult to establish a suitable company against which to benchmark, but that it is possible to at least ask customers for data on the prices offered by their competitors for particular bids for which they were unsuccessful.

Theoretically benchmarking remains worthwhile, but in practice it may be too expensive for small firms. However, this issue remains in the model as research by Rietz and Rotzoll (1997) illustrated that a consultant database has been established to enable SMEs to do benchmarking without much effort. It contains collections of data from many SMEs that have been benchmarked before, that could reduce the difficulties and cost intensive search process for appropriate companies.

9.2. Issue that were verified with changes in order/rank

9.2.1. Principle 3: Collaborate with customers

As discussed in Chapter 4, universalistic WCM models assume that collaboration can be based on identifying product or customer related families and establishing a team focus around these families. In Chapter 5, it was proposed that in MTO companies, team working can usually only be based on functional activities given the high product variety and the often constantly changing customer base. The case study evidence confirms this assertion in two ways. Firstly Company D was in fact the only one of the six companies that had successfully set up a team working policy, with three functional teams: green for welding, drilling and grinding; yellow for assembly and painting; blue for guillotining, punching and folding. Thus this evidence confirms the assertion that where teams can usefully be established, a functional basis can work well. Secondly, although some of the companies have achieved regular, repeat customer contact, this has not been possible for companies A and C. This evidence therefore also confirms the need to base the collaboration referred to in principle 3 on good relationships with the current customer base, avoiding the use of customer focussed teams.

Table A2.3 indicates which of the 5 steps of the original version of this principle have been achieved by the six companies. This evidence suggests that the ranking of the 5 steps should be altered. All of the companies are helping customers define their needs into product specifications as described in step 4, yet only two companies were found to

have a good overall understanding of customer objectives and needs as required in step 1. On reflection, it seems likely that the former will be easier to achieve. These companies tend to employ highly skilled design engineers, who specialise in developing product specifications. However, this can be done in consideration of the specific task in hand without a good knowledge of the overall operation of the customer. Therefore, the ordering of these steps have been switched around. It is also suggested that ‘getting customer representatives on the project’ in step 3 is harder to achieve and thus it is ranked at level 4 in the final version of SHEN. In fact, the inclusion of this issue in the final version remains a little controversial as no evidence illustrates that it can be achieved by the SME MTO companies, but it remains theoretically a good idea, for the reasons described in Chapter 5. Therefore, the ordering of these steps have been changed in the final version of SHEN as shown in Table 9.1.

Table 9.1: *Modification to Principle 3*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 3: Collaborate with customers;</i>	<ol style="list-style-type: none"> 1. <i>Company helping the customers define their current needs in the form of product specifications and design;</i> 2. <i>Establish a personal relationship between employees and customers;</i> 3. <i>Having good communication among employees, a common understanding of organisational objectives and customers current needs;</i> 4. <i>Getting customer representatives on the project;</i> 5. <i>Helping the customers meet their goals, rather than providing customer’s wants.</i> 	<p>Step 1: <i>Having good communication among employees, a common understanding of organisational objectives and customers needs;</i></p> <p>Step 2: <i>Establish a personal relationship between employees and customers;</i></p> <p>Step 3: <i>Getting customer representatives on the project;</i></p> <p>Step 4: <i>Company helping the customers define their needs into product specifications and design;</i></p> <p>Step 5: <i>Helping the customers meet their goals, rather than providing customer’s wants.</i></p>

9.2.2. Principle 4: Simplify the shop floor.

The first level requires the shop floor to have improved visibility, using simple storage systems to reduce the search times. Each companies' management agreed that improving shop floor visibility can help reduce the search time for materials and components. For example, the raw materials for companies A, B, C and D are placed near the relevant machine to reduce the need for a warehouse of components. However, the storage systems in companies E and F were different. Even though their storage areas are big, proper labelling makes the searching task easier whenever needed. They claimed that placing raw materials in one location makes the shop floor cleaner and hence improves visibility. The only drawback to this system is that it requires a bigger space and needs someone to be responsible or to monitor the storage. So, although the system implemented by A, B, C and D has advantages, at the first level all of the companies have found appropriate ways of ensuring search times are kept to a minimum.

The second point level requires the firms to improve their storage systems further so that they can be deemed more efficient. The movement of raw materials in companies' A, B, and D is efficient. However, the tooling system is still an issue for them. Due to misplacement, much time has been wasted searching for the right tools when needed. Two companies, B and D agreed with the suggestions to improve the tooling systems and were willing to give it a try. However, Company's A management was still unsure whether the idea is worth the cost of the investment required. The tooling system in

Companies E and F is good but the storage systems for materials and components need improving further because the placing of raw materials in one location means that the distances for movement of materials are too great. Only one company, Company C has both a good storage system and proper placing of tools.

At the third level, the firm is required to provide training to its workers on the importance of using the storage systems and of taking responsibility for their own housekeeping. This was done by Company C, D, E and F in which supervisors/team leaders have been given the responsibility to provide the necessary training to their subordinates.

The fourth level requires the firm to discipline its workers to do the housekeeping job. The evidence from the three companies, C, E and F illustrated that good housekeeping can be successfully achieved without it becoming part of company culture. Instead it was achieved by having close supervision by the management. In Company D, housekeeping is part of the company culture in which employees as a team do the task without supervision. The company has three teams and every month the housekeeping achievement was compared and displayed on a board. Thus this company has achieved level 5 in this principle.

However, two companies, A and B don't do any housekeeping. Company B agreed that housekeeping could be implemented and claimed that assigning the new responsibility to the employees should not be a problem because it is written into the employee's contract. In contrast, the MD of Company A is not willing to try this because he believes that

employee attitudes are hard to change. Given these difficulties, the management was not convinced that this would be successful. This is clearly not true in the case of the other 5 companies above and so this issue remains in the model.

Therefore, as each level has been successfully achieved by at least one case study company, (see Table A2.4 for details), the evidence suggests the five levels of improvement in principle 4 are relevant to MTO companies. However, it seems that levels 3 and 4 are easier to achieve than level 2, so these levels have been changed in rank in the final version of SHEN, as shown in Table 9.2.

Table 9.2: Modification to Principle 4

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 4: Simplify the shop floor;</i>	<ol style="list-style-type: none"> 1. <i>Improve visibility, use simple storage systems to reduce search times;</i> 2. <i>Train shop floor employees on the importance of using the storage systems and of taking responsibility for their own housekeeping;</i> 3. <i>Implement housekeeping so that work areas are clean as well as ensuring that the storage systems are properly used;</i> 4. <i>Improve locations of raw materials, WIP etc. to cut distances for movement of materials and tools;</i> 5. <i>The operator takes over his own housekeeping.</i> 	<p>Step 1: <i>Improve visibility, use simple storage systems to reduce search times;</i></p> <p>Step 2: <i>Improve locations of raw materials, WIP etc. to cut distances for movement of materials and tools;</i></p> <p>Step 3: <i>Train shop floor employees on the importance of using the storage systems and of taking responsibility for their own housekeeping;</i></p> <p>Step 4: <i>Implement housekeeping so that work areas are clean as well as ensuring that the storage systems are properly used;</i></p> <p>Step 5: <i>The operator takes over his own housekeeping.</i></p>

9.2.3. Principle 12: Improve quality and implement appropriate performance measures.

At the first level, the firm needs to establish a culture that supports continuous improvement in all processes. This has been achieved only in company D, in which employees work as a team to improve their own processes. This company has a Quality Manager to guide the company to aim for continuous improvement in all processes. At the second level, all the six companies' management agreed that every body on the shop floor must be responsible for the quality of their products.

They also agreed that QSFV is very important because this is what the customers are looking for but claimed that there should be priorities among them, as suggested by the third level. For example in Company D, the quality issue is considered to be an important objective and the responsibility to train the shop floor workers was given to the Quality Manager. In Company B, the flexibility of employees and machinery are considered to be important objectives to produce high variety low volume customised furniture in order to compete in the furniture market. Company A, C, and F are concerned with quality and flexibility, while Company E is concerned with quality and speed. As described in Chapter 8, Company E aims is to provide quick delivery, faster quotes, and reduce set-up times to a maximum of 15 minutes for most of its processes. For instance, Company E has introduced 'fastrack' products as another alternative to provide faster quotes and quick delivery to its customers. Thus this evidence confirms the assertion made in Chapter 4 and 5 that the MTO firm may have some prioritisation between these four

objectives QSFV and training should be given based on the relative importance of the company objectives.

At the fourth level, the QSFV objectives, as defined in step 3, should be the dominant performance measures. As discussed in Chapter 8, Companies D, E and F use root cause analysis (problem solving), first order results (e.g. defects rate), second order results (e.g. sales growth, productivity) and bottom line (e.g. profit) to measure their performance. However, Company C used only productivity, profit and sales growth, while Companies A and B used only profit and sales growth to measure their companies' performance. They claimed that their existing measurements are already good measures to indicate the company performance and that it is worthless for a company of their size to implement a new kind of performance measurement. Although it is acknowledged that for small companies, it is difficult to find the time and resources to calculate further performance measures, this issue would still be worthwhile for them if it could be achieved. Therefore it was concluded that level 4 should remain an important part of the model for all size of company.

At the fifth level, it is necessary to get rid of "second order" performance measures. As stated in Chapter 5, the reason is that "second order" performance measures are irrelevant to the company's real business objective. No companies yet achieved level 5 because second order measures such as sales, profit and productivity are still considered to be as important as defect rates and problem solving in all the six companies. However, as there

was no evidence to dispute the reasons for including this level as discussed in Chapter 5, it remains in the model.

Although the case study evidence did not lead to any changes in the content of this principle, the order in which it seemed realistic to achieve them was in question. Initially “maintaining a culture that supports continuous improvement in all processes” was ranked at level 1, but is now placed at level five because the evidence presented in Appendix A12 suggested that this step is the hardest concept to implement amongst the five. Previously it was believed that before any improvement could be made, the management needs to develop a culture that can support any changes on the shop floor, so that any new concept could be easily implemented without many queries. However this is not true, as the evidence demonstrated that some aspects of QSFV exist on the shop floor due to the characteristics of the MTO process and not because of a culture specifically developed to allow change. Therefore the order of the steps was switched around as shown in Table 9.3.

Table 9.3: *Modification to Principle 12*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 12: Improve quality and implement appropriate performance measures;</i>	<ol style="list-style-type: none"> 1. <i>Practice the principles of quality;</i> 2. <i>Understanding (through training if necessary) in universal customer wants: quality speed, flexibility or value (QSFV);</i> 3. <i>QSFV are dominant performance measures;</i> 4. <i>Second order performance measures (e.g. labour productivity, variance) no longer managed.</i> 5. <i>Maintain a culture that supports continuous improvement in all processes;</i> 	<p>Step 1: <i>Establish a culture that supports continuous improvement in all processes;</i></p> <p>Step 2: <i>Practice the principles of quality;</i></p> <p>Step 3: <i>Understanding (through training if necessary) in universal customer wants: quality, speed, flexibility or value (QSFV);</i></p> <p>Step 4: <i>QSFV are dominant performance measures;</i></p> <p>Step 5: <i>Second order performance measures (e.g. labour productivity, variance) no longer managed.</i></p>

9.3. Issues that were modified

9.3.1. Principle 2: Design for products, processes and improved supplier relationships.

As stated in Chapter 2, Principle 2 is to cut out wasteful practices in product design and delivery. All companies' management claimed that training to understand the product design process at the first point level is necessary because the companies need to manufacture products based on new designs and specifications. However, in terms of knowing their suppliers all the six companies' management disagreed that employees should be informed about the company's suppliers. Except for purchasing people, they claimed that there is no point informing other workers since they are not involved in purchasing. Even though they disagreed with the latter, all the six companies were given a tick at the first point level. This is because they provide an in-house training and in some cases employees were sent to outside organisation to obtain some experience which is the main issue for step 1. However, in retrospect it does not seem to be a very important issue for a WCM model and thus this step was removed from the final SHEN model.

At the second level, the evidence from the six companies suggests that having a computerised design database can reduce the time for product design which in turn can shorten the response time to customer enquiries. All companies have drawings that can be modified based on customer preference such as size, configuration and finishing. In Companies A, B and F, the data must first be input manually. In Companies C, D and E,

many drawings are imported directly from the customer's own computer. Their CAD/CAM systems can accept drawings through e-mail converted in DXF format and stored in the main computer for modification. The latter is obviously better because the modification could be done immediately through the computer and then the drawings could be send back to customers through the computer for verification. This could reduce further the time for product design which in turn can shorten the response time to customer enquiries.

For the third level, the evidence illustrated that all the six companies have successfully reduced the number of suppliers for their product. This is in contrast to the assertions made in chapter 4 that having fewer suppliers in the MTO environment is less likely to be achievable. All companies agreed that when there are too many suppliers, there is no time to establish a firm partnership with any of them. For example, Company D at one time had around 300 suppliers but reduced this to twenty major suppliers. Two suppliers delivered most of the sheet metal and a single supplier supplies nuts and bolts every month. Another Company, Company F, has around 100 suppliers but 50% of the company's spending is with 4 or 5 suppliers only.

In terms of repeat business referred to in steps 4 and 5, the case study evidence of the six companies illustrated that this idea is worth aiming for. However, Company C's experience illustrated that in some MTO companies, the level of achievement will only be level three of this principle because it is not possible for a company of this type to have repeat business with its end-user customers. Further improvement is unnecessary

because the end-user customers are usually small farmers, and having replaced a new SILOS, for example, they are unlikely to come back for another product within a short period of time. As described earlier in Chapter 5, the last two steps of this principle are included for the RBCs, and may not be achievable for some VMCs. However Company B illustrated that some VMC's may also gain repeat business by developing long term relationships with their trade customers and therefore steps 4 and 5 are also relevant to them. Also, Company A, though having no repeat customers at present, had developed a long-term customer in the past, and agreed that this has benefits when it can be achieved. However, in this case, it was not thought to be something that the company could aim at. As discussed in chapter 7, the MD felt that the 'pirate ship' nature of the company means that opportunities for long-term customer relationships are rare. This issue is therefore retained in the model, but needs to be assessed with care as it may not be a potential improvement for all companies.

This principle needs modifications because the evidence from the case study shows that some steps are easier to achieve than others in the lower ranking and some steps need to be split into two. Table A2.2 in Appendix 2 indicates which of the 5 steps of the original version of this principle have been achieved by the six companies. In step 2, all the six companies were using a computerised design database that can be modified to make drawings and product. However, having a direct computer link with the customer and the shop floor only occurred in three companies, C, D and E. Thus, it was thought to be appropriate to break down the old step 2 into 2 steps as shown in Table 9.4 as the new steps 2 and 3. The new step 2 now refers to a computerised design database with designs

that can be altered for new orders, and the new step 3 refers to a direct computer link/directly modified drawings with the customer and the shop floor. The latter is obviously better because this could reduce further the time for product design, which in turn can shorten the response time to customer enquiries.

The evidence also suggests that the ranking of the 5 steps should be altered. As shown in Table A2.2, the old level 2 is harder to achieve than the old level 3. Thus the order of the steps was switched around as shown in Table 9.4. In relation to step 4 and 5, the case study evidence showed that two RBC companies and one VMC had already achieved more than 50% repeated business. Thus it was thought to be appropriate to modify steps 4 and 5 with higher targets for the repeat business.

Table 9.4: *Modification to Principle 2*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<p><i>Principle 2:</i> <i>Design for products, processes and improved supplier relationships;</i></p>	<ol style="list-style-type: none"> 1. <i>Having a minimum number of parts, forgings or suppliers for each product;</i> 2. <i>Having a computerised design database with designs that can be altered for new orders.</i> 3. <i>Having a direct computer link/directly modified drawings between the database and the customer/shop floor;</i> 4. <i>Achieve 50% "repeat business" which makes it possible to establish partnerships with some of the suppliers;</i> 5. <i>Achieve 80% "repeat business".</i> 	<p>Step 1: <i>Train employees in understanding all the product specifications, product design rework and purchasing process/ knowing their suppliers;</i> Step 2: <i>Having a computerised design database with designs that can be altered for new orders;</i> Step 3: <i>Having a minimum number of parts, forgings or suppliers for each product;</i> Step 4: <i>Achieve 30% "repeat business" which makes it possible to establish partnerships with some of the suppliers;</i> Step 5: <i>Achieve 50% "repeat business".</i></p>

9.3.2. Principle 6: Improve scheduling and workload control to cut flow times.

The first level of this principle requires everybody on the shop floor to be trained to understand job shop sequencing, queuing, workload control and handling priority. All the six companies' management agreed with this idea. However, similarly to step 1 in principle 2, step 1 in this principle also does not seem to be a very important issue for a WCM model and thus it was removed from the final SHEN model.

At the two-point level, the MTO production control system does not need to be computerised. For example Company C already make effective use of manual production control boards to display “work-to” lists or to schedule the jobs. Five companies A, B, D, E and F, already make use of computer print-out to help in their scheduling process. Company F uses simple spreadsheet lists called “hit lists” with delivery dates and everybody must work on the products in that list, in the order given.

The third level requires the MTO company to use a computerised scheduling software package in its production control system. Company D uses MRP to do the scheduling task and Company B uses the EXCEL package. Even though they are using these computer packages, there is no evidence that flow time has been reduced. Workload control is still needed as a means to gain better control of flow times as described in Chapter 4. This assertion was backed by the opinion of one of the company MDs in particular, the MD of Company F. He felt that the current software packages available,

such as those based on MRP do not work well in MTO companies and therefore, he was interested to find out more about the alternative workload control systems being proposed in the model.

The fourth and fifth level of improvement suggests that companies should achieve some improvement in their flow times but no company yet among the six achieves these levels. Although Company A believes its flow times are reasonable, the other five companies agreed that their flow times should be reduced. With a proper method of workload control to aid the company to reduce flow times, the target of 30% in step 4 and 50% in step 5 are still considered realistic, as there is no evidence to the contrary.

In Table A2.6, all of the companies have been given a tick for step 2 as they use simple scheduling methods (most commonly the Earliest Delivery Date dispatching rule), and companies B and D have computerised systems to aid in the planning process. However, none of these companies have addressed the issue of workload control and none are yet achieving any of the desired reduction in flow times. This evidence therefore suggests that simple scheduling rules alone cannot achieve this important aim and thus an alternative system, such as workload control, is needed. Thus in the final version of SHEN as shown in Table 9.5, the issue of workload control is separated out from scheduling so that this is not addressed until step 3.

Table 9.5: *Modification to Principle 6*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 6: Improve scheduling and workload control to cut flow times;</i>	<ol style="list-style-type: none"> 1. <i>Having a practical, simple and easily implemented manual scheduling system;</i> 2. <i>Having a simple computerised scheduling system which can be modified as priorities change;</i> 3. <i>Having an effective method of workload control to aid the company to reduce flow times;</i> 4. <i>Achieving average reduction of flow time by 30%;</i> 5. <i>Achieving average reduction of flow time by 50%.</i> 	<p>Step 1: <i>Train associates in readiness on job shop sequencing, queuing limitation, workload control, handling priority;</i></p> <p>Step 2: <i>Having a practical, simple and easily implemented workload control or scheduling system;</i></p> <p>Step 3: <i>Having a computerised database system for scheduling/workload control;</i></p> <p>Step 4: <i>Achieving average reduction of flow time by 30%;</i></p> <p>Step 5: <i>Achieving average reduction of flow time by 50%.</i></p>

9.3.3. Principle 7: *Cut the start up/changeover time and improve preventive maintenance.*

All the six companies’ management claimed that set-up/changeover time reduction and preventive maintenance as stated at the first level was beneficial to the company. However, most skills are gained through many years of experience using the machinery. Several suggestions to reduce set-up time were discussed during the case study visits. For instance, Company C’s management felt that one possible way is to have better planning so that similar jobs requiring similar tooling are done one after another. Company F claimed that the set up time could be improved if the tools were immediately taken off after the job’s finished, put in a special carrier and given to somebody else to sharpen the tools for the next job. On the other hand, companies A and D were concerned about producing better tools, which will minimise the set up as well as the cutting time in most

machines. Company A would be able to produce the tools by themselves but Company D would need to find someone else to produce tools. Finally, Company B suggests that having enough tools and keeping them in their proper places could reduce the set-up time. All of these suggestions were discussed as ways of further reducing the set up times in the companies.

The evidence from the case studies shows that only one company has successfully achieved a 20% reduction in their set-up time. In fact this company, Company E has been trying very hard to reduce its set-up times and being able to achieve 30% reduction as stated in level 4, and shown in Table A2.7 in Appendix 2.

Level 5 requires the company to search for ways to reduce its set up time further by 50%. However the target of 50% was too high and not realistic since there is no evidence that the companies could achieve this level. For example, Company E illustrated that when quick release tools for CNC machinery is properly in use, the set-up time could only be reduced by 30%. This company did not think it could reduce set up times further.

The case study evidence suggested that several minor modifications to this principle would make it more appropriate to the MTO sector. Initially step 2 was given a target of “20% average reduction in set-up/changeover time”, but then reduced to 10% because the case study evidence suggested 20% attainment is high as a first target as many companies had only achieved between 10-20% despite making definite improvements. Similarly in steps 4 and 5, the target rates were originally 30% but then reduced to 20% in step 4; and

50% but then reduced to 30% in step 5. Changes to principle 7 are shown in Table 9.6 below.

Table 9.6: Modification to Principle 7

Title	Breakdown points	Previous (Before alterations)
<p><i>Principle 7: Cut the start up/ changeover time and improve preventive maintenance;</i></p>	<ol style="list-style-type: none"> 1. <i>Train associates in set-up/ changeover reduction and basic preventive maintenance;</i> 2. <i>Achieving 10% average reduction in set-up/ changeover time;</i> 3. <i>Operators can take over their own preventive maintenance;</i> 4. <i>Achieving 20% average reduction in set-up/changeover time;</i> 5. <i>Employees achieve 30% reduction in set-up/ changeover times across all processes.</i> 	<p>Step 1: <i>Train associates in set-up/ changeover reduction and basic preventive maintenance;</i> Step 2: <i>Achieving 20% average reduction in set-up/ changeover time;</i> Step3: <i>Operators can take over their own preventive maintenance;</i> Step 4: <i>Achieving 30% average reduction in set-up/changeover time;</i> Step 5: <i>Employees achieve 50% reductions in set-up/ changeover times across all processes.</i></p>

9.3.4 Principle 8: Improve information flow.

The first level requires that job priorities are clearly understood by employees and that everyone on the shop floor is working to the same plan. One company, Company C illustrated that even though in some cases they have had a rough unwritten schedule, it was at least understood by all employees. At the two-point level, computers have been used to reduce internal transactions in all six companies. For example, Companies A and F hold data on employee attendance, personal records, salary, company purchasing.

Company C is using the “SAGE” database for wages linked to the attendance swipe card machine.

Regarding level 3, three companies B, D, and E claimed that some information on quality, cost, orders, delivery and design is available and workers are given permission to access it. Levels four and five require more reduction in internal and external transactions. Company D uses a computerised database system to set employee rates of pay, tax, National Insurance etc. Regarding external transactions, most work is done using the fax machine. E-mail is mostly used in the engineering department. Many of the customer drawings are sent by e-mail. Three companies, C, D and E currently used software that link CAD/CAM design directly to the shop floor to shorten the information flow. Some “external transactions” are sent by fax machine.

This principle needs changing because the evidence showed that all the six companies were already making better use of the fax/internet for external transactions than had at first been assumed. Thus it was thought to be appropriate to break down the old step 5 into 2 steps with higher targets for the internal and external transactions. However, the question arises as to what realistic targets should be given. It was decided that the highest target should be 99% because many companies claimed that email and Fax machines have been used widely to cut external transaction. Regarding the internal transaction, the highest target was 80% because three companies, A, B and D have successfully reduced these by more than 50% but agreed that this area could still be improved. To make space for level 5 to be split into two, and still retain the five-step structure, level three was

removed as it was thought to be less important than the other issues covered. In addition, the wording of the old step four was changed to make it clearer. The changes are all shown in Table 9.7 below.

Table 9.7: Modification to Principle 8

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 8: Improve information flow;</i>	<ol style="list-style-type: none"> 1. <i>Job priorities are clearly understood by all and everyone is working to the same plan;</i> 2. <i>Having a systematic method to communicate the plan including manual systems such as a planning board or 'work to lists' produced by an appropriate software package;</i> 3. <i>Office transactions, labour transactions cut by 25%;</i> 4. <i>Internal transactions cut by 50% and 80% of external transactions are done by fax/Internet/EDI;</i> 5. <i>Internal transactions cut by 80% and 99% of external transactions are done by fax/Internet/EDI.</i> 	<p>Step 1: <i>Job priorities are clearly understood by all and everyone is working to the same plan;</i></p> <p>Step 2: <i>Having a systematic method to communicate the plan including manual systems such as a planning board or 'work to lists' produced by an appropriate software package;</i></p> <p>Step 3: <i>Having information about quality, cost, orders, delivery, and design that is readily available anytime to all in the factory;</i></p> <p>Step 4: <i>Workflow, quality, internal scheduling and labour transactions cut by 25%;</i></p> <p>Step 5: <i>Internal transactions cut by 50% and 50% of external transactions are done by fax/ Internet/ EDI</i></p>

9.3.5. Principle 9: Make rapid improvements in skills and flexibility.

All companies' management agreed with the first level that the company should implement a training programme for all associates to increase relevant skills. As described in Chapters 7 and 8, a variety of methods have been planned by the management to increase employee skills further, including in-house training or sending

them outside to be trained by the machine suppliers. The second and third levels require the MTO Company to reach a point whereby first 80% and then 99% of workers have the flexibility to work on any machine. This was achieved by only one VMC company, Company A. Similarly, only Company A has achieved level 5. However step 4 was also achieved by Company B because employees can do some minor repairs. As stated in Chapter 7, 75% of the minor breakdowns are repaired by the machinist.

However there is some conflicting evidence from the other four companies C, D, E and F who argued that total flexibility is not needed in some cases. In the first version of the model in Chapter 5, it was assumed that the level of worker flexibility that would be required for a MTO company would be even greater than required for firms that make similar products on a repeat basis. As MTO firms make a high variety of different products, it was assumed that the demand for certain skills would vary greatly over time and thus it would be important to move people around as the need arose. However, the conclusion of the case study evidence is that this is not the case. Instead, it was suggested by the management of company D that a training needs matrix should be set up to establish how many people should be skilled in each function and which employees to train. Once this level of expertise has been gained, any further training is expensive and unnecessary. It is also soon wasted as without the experience of using the new skill it will be quickly forgotten. Similar opinions were expressed by the management of companies B, C and E. Company F had in fact attempted a programme of job rotation to provide workers with some variety, but this was soon abandoned with workers preferring to stick to the tasks that they felt they were good at performing.

Therefore to make this principle relevant to all companies, the wording for levels 2 and 3 was changed to include flexibility in “*appropriate skills*” rather than “*all skills*”. The change was made because it was felt that the type of training offered to employees should be based on the company needs. Thus in the final version of this principle, as shown in Table 9.8, if 80% of the workers have attained the skills set out in the training needs matrix devised at step 1, then level 2 will have been achieved and so on. It is also important to note that the title of this principle was changed slightly in wording from “*rapid*” to “*essential*” to reflect the revised wording of the levels.

Table 9.8: *Modification to Principle 9*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<p><i>Principle 9:</i> <i>Make essential improvements in skills and flexibility;</i></p>	<ol style="list-style-type: none"> 1. <i>Implement a training programme for all associates to increase relevant skills;</i> 2. <i>80% of associates are flexible in appropriate skills and able to work on other machines when needed;</i> 3. <i>99% of associates are flexible in appropriate skills and able to work on other machines when needed;</i> 4. <i>Experts teach operators to do repairs; downtime cut by 50%;</i> 5. <i>Operators become technicians; downtime cut by 80%.</i> 	<p>Step 1: <i>Implement a training programme for all associates to increase relevant skills;</i></p> <p>Step 2: <i>80% of associates are flexible in skills and able to work on any machine;</i></p> <p>Step 3: <i>99% of associates are flexible in skills and able to work on any machine.</i></p> <p>Step 4: <i>Experts teach operators to do repairs; downtime cut by 50%;</i></p> <p>Step 5: <i>Operators become technicians; downtime cut by 80%.</i></p>

9.3.6. Principle 14: Promote/market/sell every improvement.

All companies' management agreed with the first level of this principle that the promotional campaign should be carried out using trade exhibitions, trade journals, telephone calls, direct mail, internet web pages or the yellow pages phone book. The second level requires the special MTO features, which may include some of QSFV or other performance measures to be publicised. Companies D, E and F already make effective use of some of these measures in selling their products. The third level requires a lot of company effort to gain international recognition such as state awards or ISO 9000 awards. Five of the companies have achieved ISO 9002 recognition.

The fourth level requires MTO firms to go beyond ISO 9000 or state awards to aim for national or global awards. Four companies, A, B, D and F, were not interested in going for further external accreditation unless there was evidence that their customers required it. For example, company B does not have ISO9000 and has no intention of gaining it as there is no pressure from their customers. However, given evidence that the level of customer pressure varies from one firm to another, as in the case of Companies C and E, this issue is still included in the model so that it can be considered as a potential improvement where relevant. The companies need to assess whether or not it is appropriate to have further accreditation for their particular line of business. Possibly the accreditation is needed more when the company have a certain type of product (i.e. farm equipment for Company C and doors for certain purposes for Company E).

The fifth level of achievement for this principle is where the company is able to choose whom to sell to because of its strong market position. However, no companies among the six have yet attained this level. In fact, the inclusion of this issue remains a little controversial as no evidence illustrates that it could be achieved by the MTO companies, but it remains theoretically a good idea.

This principle was modified because the response of the six companies personnel suggested that the initial step 4 “global/national awards i.e. Baldrige” was a very tough target for SME’s. As illustrated by two companies, C and E, it can be just as worthwhile to have local recognition such as New Innovation Award, New product Award, Machinery Award and so on. Thus step 4 now includes local awards as well as global/national awards, as shown in Table 9.9.

Table 9.9: Modification to Principle 14

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 14: Promote/market/sell every improvement.</i>	<ol style="list-style-type: none"> 1. <i>Having good advertisements with effective placing (newspaper, magazine, etc.) for the target customers;</i> 2. <i>Positive QSFV trends featured in selling, bids, proposals, ads;</i> 3. <i>Registration; certifications; local awards (ISO-9000, Ford Q1, state award);</i> 4. <i>Other local / national/ global awards;</i> 5. <i>Reverse marketing: Out of strength, you choose whom you sell to.</i> 	Step 4: <i>Global/national awards (e.g. Baldrige)</i>

9.4. Issues that were merged

9.4.1 Principle 10: Have systematic rewards, recognition and monetary payment.

None of the companies visited were convinced that performance appraisal in level 1 is appropriate. For example, the management of companies A, B and C believed that formal appraisal is worthless because there is less prospect of promotion in SMEs. Instead a first step in the right direction seemed to be having an effective means of showing appreciation for worker effort or attainment. Five companies A, B, C, E and F believed that formal recognition or celebration of achievement is useless for their company. They claimed that monitoring the employees' performance is quite difficult. However given the evidence that it works well for Company D and therefore is workable in British culture, this idea is maintained in the model. Levels 4 and 5 are concerned with other kinds of awards given to employees such as through cross training, cross careering and paying for knowledge in addition to the basic salary. However, there is no evidence that MTO companies can achieve levels 4 and 5 since all the company managers were not convinced about the ideas of cross careering, cross training, or paying for knowledge. If multi-skilling is less desirable for the reasons discussed in 9.3.5, then rewarding for this is irrelevant.

Therefore steps 1, 4 and 5 were removed from this principle with only steps 2 and 3 left. This principle was then merged with the original principle 11 because some of the issues are related to the issues in steps 1, 2 and 4 there. For example, only Company D had

achieved success through rewards and this was mainly through the suggestion scheme which is part of Principle 11.

Table 9.10: *Modification to Principle 10*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<p><i>Principle 10:</i> <i>Have systematic rewards, recognition and monetary payment;</i></p>	<ol style="list-style-type: none"> 1. <i>Systematic public recognition/ celebration of achievement;</i> 2. <i>Variety of low-cost awards to both teams and individuals;</i> 	<p>Step 1: <i>Having a systematic performance appraisal system;</i> Step 2: <i>Systematic public recognition/ celebration of achievement;</i> Step 3: <i>Variety of low-cost awards to both teams and individuals;</i> Step 4: <i>The company is investing in employees via training, cross training, cross careering;</i> Step 5: <i>The company reward for skills/knowledge; team/unit bonuses.</i></p>

9.4.2 Principle 11: Everybody involved in change and strategic planning – to achieve a unified purpose.

Four out of six companies claimed that they have strategic planning but the planning in two companies, B and F was not well documented. This suggests that step 1 is appropriate to MTO companies. At the second level, the company needs to inform its workers about its strategic plan and share the relevant data (e.g. whether aims are being met) with its shop floor employees. Some companies' management felt that the plan was confidential and therefore not many people were allowed to look at it. However given the evidence that it was applicable for Companies D and E, this idea is worth aiming for. For

instance employees in Company D have used the data to analyse the defect rate in the company.

The third level requires the frontline employees/teams/supervisors to use process analysis to plot trends. The idea still seems worthwhile for the reasons given in Chapter 5 but so far there is no evidence that this step is workable or of particular importance in MTO companies as no companies have yet attained this level. In retrospect it seems less important than the other issues in this principle.

At the fourth level, employee suggestions to improve the process are definite indicators of process ownership. However, attitudes towards the giving of responsibility to the workers varied across the six companies and seemed to be a result of the management personalities. In company D, a suggestion scheme has been successfully introduced whilst company C found that most of the suggestions they had received were not helpful. As described in Chapter 8, in company D, there has been a recent payment of £150 shared between three workers who came up with a very simple solution that is expected to save the company an average of £10,000 a year. In company C paying for suggestions has been abandoned. However, the company claimed that they still welcome suggestions from its workers. Therefore no change has been made to step 4.

Level 5 requires the involvement and commitment of the customers in the company's strategic plan. Similarly to level 3, no companies yet achieved this level and there is no evidence that step 5 is important to the MTO company. Therefore, as it seemed desirable

to merge principles 10 and 11 and to retain the 5 step structure, neither steps 3 nor 5 have been retained in the final version of SHEN. Indeed for step 5, it could be argued in retrospect that this issue is not particularly pertinent given the regular changes in customer base that occur in some MTO companies.

Thus the three remaining new steps for principle 11 are as shown in Table 9.11. Levels 1, 2 and 4 were switched around because the case study evidence suggested that ‘suggestion schemes’ are an easier concept to implement than the notion of ‘sharing information with shop floor employees’ or of ‘having strategic planning’.

Table 9.11: *Modification to Principle 11*

<i>Title</i>	<i>Breakdown points</i>	<i>Previous (Before alterations)</i>
<i>Principle 11: Everybody involved in change and strategic planning – to achieve a unified purpose;</i>	<ol style="list-style-type: none"> 1. <i>Encourage employees to make suggestions to improve the process;</i> 2. <i>Having strategic planning;</i> 3. <i>Sharing information and records with shop floor employees;</i> 	<p>Step 1: <i>Having strategic planning;</i> Step 2: <i>Sharing information and records with shop floor employees;</i> Step 3: <i>The frontline employees/ teams/supervisors use process analysis, plot trends;</i> Step 4: <i>Encourage employees to make suggestions to improve the process;</i> Step 5: <i>The company gains the involvement and commitment of customers in their strategic plan.</i></p>

9.4.3 Conclusion for the merged principle (Principle 10 & Principle 11)

As described earlier in section 9.4.1, the first change to the model was to completely remove two steps in an original principle 10 that was labeled: ‘Having systematic rewards, recognition and pay’. The last two steps of this initial principle were related to issues of cross training, cross careering and rewarding workers for developing new skills. If multi-skilling is less desirable for the reasons discussed earlier, then rewarding for this is irrelevant. In fact this principle has now been removed altogether. Only one of the six companies, company D, had achieved success through rewards and this was mainly through the suggestion scheme which is part of the principle entitled ‘everybody involved in change and strategic planning - to achieve a unified purpose’. This is principle 9 in the final version of the model. It has maintained its original title, but now contains some of its original steps as well as two of the steps from the original principle regarding rewards.

Table 9.12: *New principle 9 in the final SHEN model*

<i>Title</i>	<i>Breakdown points</i>
<i>Everybody involved in change and strategic planning – to achieve a unified purpose;</i>	<ol style="list-style-type: none"> 1. <i>Encourage employees to make suggestions to improve the process;</i> 2. <i>Having strategic planning;</i> 3. <i>Sharing information and records with shop floor employees;</i> 4. <i>Systematic public recognition/ celebration of achievement;</i> 5. <i>Variety of low-cost awards to both teams and individuals;</i>

Table 9.12 presents the new version of principle 9. It could be argued that that steps 2 and 3 don’t fit particularly well in this principle. In fact, there was some difficulty in deciding whether steps 2 and 3 should be placed before steps 4 and 5 or vice versa. However,

given that it seemed preferable to continue to structure the model as a set of principles with five steps in each one, it was felt that there is sufficient connection between the issues in this new version of principle 9. This connection is the underlying concept of worker involvement and then of rewarding them for that involvement. So, for example, sharing information with shop floor workers in step 3 will better enable them to contribute to the company. This could then lead to awards being given in recognition of that contribution in steps 4 and 5.

9.5. Issues that were dropped

9.5.1. Principle 5: Seek simple, flexible, movable, low-cost equipment in multiples.

The original version of SHEN contained a principle that was entitled: ‘Seek simple, flexible, movable, low-cost equipment in multiples’. As discussed in chapter 5, this has the same title as a similar principle in Schonberger’s (1996) model, although the steps had all been redefined. The assumptions behind the inclusion of this issue were that the high level of product variety would require flexible equipment. Indeed, all six case studies confirmed that they require flexible machinery, but only one of the six companies required movable machinery. This was company A, whose premises were not big enough to hold all of their machines. They therefore had an arrangement to keep some in store to be interchanged with machines in the factory as necessary. As this firm is based in Morecambe, and the store is in Preston, this is far from an ideal situation and not an exemplar of best practice. Indeed the thinking behind the original principle is that

machinery can be moved around on site to set up new temporary cells for specific products so as to increase operating efficiency, reducing WIP and so on. However, on reflection, it seems that this issue is not relevant to the MTO sector as they tend to be manufacturing too many different products at once. All six companies confirmed the need to maintain a traditional functional or process layout in order to offer the level of flexibility required by the product mix being manufactured at any point in time. The issue of simple machinery was also called into question by the data. In the MTO sector, where specific skills are often being sold, highly specialised machinery is often necessary. For example, company A, as a precision engineering firm use of lot of complex, accurate machinery which is essential to meet their quality standards. Thus this principle was completely dropped from the final version of SHEN. The only aspect that seemed to be of relevance was the need for flexibility which was obvious to the company managers and not a pertinent issue to include in a performance improvement model.

9.6. The final version of the SHEN model

Table 9.13 shows the final version of SHEN, once all of the evidence from the six case studies had been analysed and the model had been modified accordingly. Altogether, there are 12 principles covering 4 areas: generate enquiries/sales containing 3 principles; operations and capacity containing 4 principles; human resources with 2 principles; and general continuous improvement with 3 principles.

Table 9.13: *The final SHEN model*

<i>Title</i>	<i>Breakdown points</i>
<p>Generate enquiries/sales</p> <p>1. <i>Integrate the functions of production and marketing in all processes;</i></p> <p>2. <i>Design for products, processes and improved supplier relationships;</i></p> <p>3. <i>Collaborate with customers;</i></p>	<p>1. <i>Initial understanding between production and marketing;</i></p> <p>2. <i>Production and marketing functions work together in responding to customer enquiries;</i></p> <p>3. <i>Having a systematic data base system to enable MTO companies to respond to customer enquiries;</i></p> <p>4. <i>Achieve 50% reduction in time to respond to customer enquiries;</i></p> <p>5. <i>Understanding its competitors and having a systematic method for calculating price and delivery lead time (i.e. strike rate matrix).</i></p> <p>1. <i>Having a minimum number of parts, forgings or suppliers for each product;</i></p> <p>2. <i>Having a computerised design database with designs that can be altered for new orders.</i></p> <p>3. <i>Having a direct computer link/directly modified drawings between the database and the customer/shop floor;</i></p> <p>4. <i>Achieve 50% “repeat business” which makes it possible to establish partnerships with some of the suppliers;</i></p> <p>5. <i>Achieve 80% “repeat business”.</i></p> <p>1. <i>Company helping the customers define their current needs in the form of product specifications and design;</i></p> <p>2. <i>Establish a personal relationship between employees and customers;</i></p> <p>3. <i>Having good communication among employees, a common understanding of organisational objectives and customers current needs;</i></p> <p>4. <i>Getting customer representatives on the project;</i></p> <p>5. <i>Helping the customers meet their goals, rather than providing customer’s wants.</i></p>
<p>Operations and capacity</p> <p>4. <i>Simplify the shop floor;</i></p>	<p>1. <i>Improve visibility, use simple storage systems to reduce search times;</i></p> <p>2. <i>Train shop floor employees on the importance of using the storage systems and of taking responsibility for their own housekeeping;</i></p>

<p>5. <i>Improve scheduling and workload control to cut flow times;</i></p> <p>6. <i>Cut the start up/ changeover time and improve preventive maintenance;</i></p> <p>7. <i>Improve information flow;</i></p>	<p>3. <i>Implement housekeeping so that work areas are clean as well as ensuring that the storage systems are properly used;</i></p> <p>4. <i>Improve locations of raw materials, WIP etc. to cut distances for movement of materials and tools;</i></p> <p>5. <i>The operator takes over his own housekeeping.</i></p> <p>1. <i>Having a practical, simple and easily implemented manual scheduling system;</i></p> <p>2. <i>Having a simple computerised scheduling system which can be modified as priorities change;</i></p> <p>3. <i>Having an effective method of workload control to aid the company to reduce flow times;</i></p> <p>4. <i>Achieving average reduction of flow time by 30%;</i></p> <p>5. <i>Achieving average reduction of flow time by 50%.</i></p> <p>1. <i>Train associates in set-up/ changeover reduction and basic preventive maintenance;</i></p> <p>2. <i>Achieving 10% average reduction in set-up/ changeover time;</i></p> <p>3. <i>Operators can take over their own preventive maintenance;</i></p> <p>4. <i>Achieving 20% average reduction in set-up/changeover time;</i></p> <p>5. <i>Employees achieve 30% reduction in set-up/ changeover times across all processes.</i></p> <p>1. <i>Job priorities are clearly understood by all and everyone is working to the same plan;</i></p> <p>2. <i>Having a systematic method to communicate the plan including manual systems such as a planning board or 'work-to' lists produced by an appropriate software package;</i></p> <p>3. <i>Office transactions, labour transactions cut by 25%;</i></p> <p>4. <i>Internal transactions cut by 50% and 80% of external transactions are done by fax/Internet/EDI;</i></p> <p>5. <i>Internal transactions cut by 80% and 99% of external transactions are done by fax/Internet/EDI.</i></p>
<p>Human resources</p> <p>8. <i>Make essential improvements in skills and flexibility;</i></p>	<p>1. <i>Implement a training programme for all associates to increase relevant skills;</i></p> <p>2. <i>80% of associates are flexible in appropriate skills and able to work on other machines when needed;</i></p> <p>3. <i>99% of associates are flexible in appropriate skills and able to work on other machines when needed;</i></p> <p>4. <i>Experts teach operators to do repairs; downtime cut by 50%;</i></p> <p>5. <i>Operators become technicians; downtime cut by 80%.</i></p>

<p>9. <i>Everybody involved in change and strategic planning – to achieve a unified purpose;</i></p>	<ol style="list-style-type: none"> 1. <i>Encourage employees to make suggestions to improve the process;</i> 2. <i>Having strategic planning;</i> 3. <i>Sharing information and records with shop floor employees;</i> 4. <i>Systematic public recognition/ celebration of achievement;</i> 5. <i>Variety of low-cost awards to both teams and individuals;</i>
<p>General continuous improvement</p>	
<p>10. <i>Improve quality and implement appropriate performance measures;</i></p>	<ol style="list-style-type: none"> 1. <i>Practice the principles of quality;</i> 2. <i>Understanding (through training if necessary) in universal customer wants: quality, speed, flexibility or value (QSFV);</i> 3. <i>QSFV are dominant performance measures;</i> 4. <i>Second order performance measures (e.g. labour productivity, variance) no longer managed.</i> 5. <i>Maintain a culture that supports continuous improvement in all processes;</i>
<p>11. <i>Gather customer feedback and benchmarking;</i></p>	<ol style="list-style-type: none"> 1. <i>Gathering customer-satisfaction data, review complaints and make continuous improvement on products and services;</i> 2. <i>Gathering data on future customer needs;</i> 3. <i>Gathering competitive samples and best practice data;</i> 4. <i>All associates involved in customer/ competitive best practice;</i> 5. <i>The company implement full-scale benchmarking for its processes.</i>
<p>12. <i>Promote/market/sell every improvement.</i></p>	<ol style="list-style-type: none"> 1. <i>Having good advertisements with effective placing (newspaper, magazine, etc.) for the target customers;</i> 2. <i>Positive QSFV trends featured in selling, bids, proposals, ads;</i> 3. <i>Registration; certifications; local awards (ISO-9000, Ford QI, state award);</i> 4. <i>Other local / national/ global awards;</i> 5. <i>Reverse marketing: Out of strength, you choose whom you sell to.</i>

9.7. Conclusion

The case study evidence from the six companies suggests that the initial SHEN principles were relevant to the MTO companies. One of the original principles, principle 5 has been deleted and two of the others principles, 10 and 11 have been merged into one. Many of the steps of the remaining principles have also been changed. These changes mean that the original 14 principles have been reduced to 12 only. Among these twelve, two principles are the same as they were in the first version of SHEN as they were verified by the case study analysis; three principles were verified in content but the order of the 5 steps was changed; and seven principles were more significantly changed in detailed steps and wording.

The new model maintains its original structure with the principles grouped into four categories and with five steps in each principle. It could be argued that this structure is not necessary and that the issues could just be given as one big list. However it was felt that the structure could assist the company to track achievement based on related activity. In some cases, the sub-headings used for the principles and categories may also help the company to decide how to prioritise the changes needed in its improvement program.

CHAPTER 10

CONCLUSION

As described at the beginning of this thesis, one of the two main aims of this research was to determine the ‘pertinent components of a WCM model that would help companies in the MTO sector to identify and prioritise ways to improve their performance’. The main research contribution of this thesis is to provide a comprehensive model, labeled SHEN, which contains these pertinent components as derived from the case study and literature evidence, the final version of which has been presented in chapter 9. In addition, the manner in which these components can be packaged and hence implemented by companies has been explored as discussed in section 10.1 below.

The second main aim of the research was to explore whether it is sufficient to have one version of the WCM model to cover all types of MTO company or whether several models are needed. The case study evidence came from several types of MTO company, including small and medium, VMC and RBC, and the evidence suggests that one model will be adequate for all as long as it is used intelligently. This is also discussed in section 10.1, in the context of the discussion on how to implement the SHEN model.

In addition, to addressing the two main aims of the research, some of the issues identified by the case study evidence are significant research contributions in their own

right, even if not incorporated into the SHEN model. These issues are discussed in section 10.2. Finally this conclusion also lists areas for further research, as described in section 10.3.

10.1 SHEN as a practical tool to develop company improvement plans

The final SHEN model contained 12 principles, each comprising 5 steps. Level one is the first step on the road to improvement and level five relates to current best practice performance. In order to use the model, it is intended that companies will assess their current practice and performance to determine which levels of achievement they have attained for each principle. This should lead to a set of company strengths and a set of potential company improvements. The management will then need to consider the latter carefully to determine how to implement them in their particular manufacturing environment. Indeed, in some cases it may be necessary to remove some of the improvements from the list, and thus the model will need to be used carefully to make judgements of this type.

When collecting the case study evidence, the companies were all assessed in this way so that it was possible to form a judgement on whether the model could be successfully used as intended. Thus the first stage of case study analysis involved the collection of data regarding the current operations management processes. The second stage of analysis was needed to assess whether the content of the model was appropriate. Thus management were asked whether they thought the strengths were accurate and the

potential improvements were realistic in their case. They were also asked whether there were any pertinent MTO issues that they thought were missing from the model.

It is noted that it was not an original intention of the model to identify company strengths but as the case study work progressed, this idea seemed to be a useful part of the encouragement process to instigate further changes. Most of the strengths noted in the first stage of analysis were confirmed by the management during the second stage, and this gave the latter meetings a positive note on which to commence.

The analysis of the six companies illustrated that most of the advice generated by the initial model was of relevance to the companies studied. However, it also indicated areas in which the model could be improved to make it more applicable to this sector as has been described in Chapter 9. There are only a couple of issues in the final version of SHEN that will not be appropriate to all MTO companies, as discussed later in this section. As long as the model is used intelligently, and these issues are deleted from the list of potential improvements when not needed, then it is concluded that the model can be used to generate an appropriate improvement programme in the manner originally intended.

However, there are two further areas in which a deal of judgement is needed in using the model. Firstly there is the need to prioritise the changes. In the case study analysis, the potential improvements suggested for the company were categorised into short-term, medium-term and long-term. As described in Chapter 7, the placing of changes into these

categories is arbitrary in some cases, but overall it was intended that short-term issues were the easiest, cheapest changes whereas long-term issues were those that are expected to take a considerable amount of time and/or are more expensive. However, in practice, it is anticipated that the companies' themselves could decide their own priorities since the list of possible improvements given in the model is comprehensive. Ideally, the model would include a more automatic means of prioritising change, but this is as yet an area for further research as discussed in section 10.3. In the meantime, it is concluded that in the hands of company management or an external expert, a suitable priority ranking can be devised.

The second area in which judgement will be needed is in assessing how up-to-date the model is for each principle. This is essential because the definitions of best practice currently included in level 5 of each principle will of course be superseded by new ideas in the future. The evidence of the six case studies suggests that the current model will continue to provide useful advice for some time yet. However, obviously as changes are made, companies will move towards step 5 in each relevant principle and then the model will need to be up-dated. An issue for further research is to consider whether and how this can be achieved. In the meantime, it is for those using the model to add any other issues that arise.

If the model is used in the manner described above, then it seems to be relevant to MTO companies which can be categorised as small companies and those that are medium sized (Anonymous (1996); Sadler-Smith et al. (1998)). Despite very different sizes, products

and customer bases, there are enough common threads to make it worthwhile to make one model for the whole sector. This is because much of the evidence from all the six companies indicates that similar issues occur in several of the principles. For example, as described in Chapter 9, all companies' management believed that formal appraisal is worthless because there is less prospect of promotion in their companies. Another example is regarding employee suggestions. The evidence from the six companies indicates that all companies encouraged suggestions. In company D, a suggestion scheme has been successfully introduced whilst company C found that most of the suggestions they had received were not helpful. However, Company C is still welcoming employee suggestions. As stated in Chapter 9, Company D has made a recent payment of £150 shared between three workers who came up with a very simple solution that is expected to save the company an average of £10,000 a year.

However, there were also some differences in the opinions expressed regarding the feasibility of some of the potential improvements. For instance, Company D has an excellent system for low cost/ no cost awards, whilst companies A, B, C, E and F are extremely skeptical about this idea. It was suggested that it is inappropriate in a British culture. This is clearly not true in the case of company D and therefore this issue remains in the final SHEN model. Similarly with the issue of housekeeping in which the evidence from the four companies C, D, E and F illustrated that housekeeping could be implemented in their companies. Company B doesn't do any housekeeping but also agreed that it could be implemented and claimed that assigning the new responsibility to the employees should not be a problem. In contrast, Company A's MD claimed that

assigning housekeeping to employees is not possible because workers attitudes are hard to change. This is clearly not true in the case of the other 5 companies above and so this issue remains in the model. Differences in opinions of these types appear to be due to differences in personality, temperament and experience of company personnel. They are not due to the inherent characteristics of the companies – that is they are not due to their size or product base and so on.

The evidence from the case studies also illustrates that one set of guidelines will be sufficiently generalisable to be effective for both VMC and RBC. Even though there were two controversial issues that apply to some types of VMC, other VMCs illustrated that this idea is worth aiming for. Firstly, customer ‘needs’ data are important for tailored customisation (Companies B, C and E) and RBC (D and F) but not for pure customisation (Company A), especially in cases where the customer provides the design. This is because the unpredictable, ‘pirate ship’ nature of work in the MTO sector is such that there is no point collecting customer ‘needs’ data. The company has to compete and quote for jobs for new customers requiring different types of products all the time. Secondly, Company C’s experience illustrated that it is not possible for a company of its type to have a repeat business with its end-user customers who only come back after three to five years’ for the products. As described earlier in Chapter 5, the last two steps of principle 2 are included for the RBCs, and may not be achievable for some VMCs. However Company B illustrated that some VMC’s may also gain repeat business by developing long term relationships with their trade customers and therefore the issue is also relevant to them. Since there were only two controversial issues, it was felt that one

model will be adequate to represent VMC and RBC. As described earlier in this chapter, as long as it is used intelligently and irrelevant issues are deleted from the list of potential improvements, then this model could be used by all kinds of MTO companies.

10.2 Significant contribution to knowledge on MTO best practice

Although the case study evidence has primarily been used to adjust the model, it is worth emphasising that two issues have come to light that were felt to be significant insights into best practice for the MTO sector. These are described below:

- The level of multi-skilling required is less than was initially postulated by the first version of the model;
- The need for movable, flexible equipment was also much less than the model initially assumed.

The first issue arises because the case study evidence illustrated that having too much multi-skilling would end up with workers being a ‘jack of all trades’ and a ‘master of none’. Initially, it was assumed that the level of worker flexibility that would be required for a MTO company would be even greater than required for firms that make repetitive products. But this is not true as the conclusion from the case study evidence illustrate that the type of training offered to employees should be based on the company needs. As discussed in more detail in section 9.3.5, any further training is expensive and unnecessary.

The later issue arises because the evidence suggests that movable types of machinery are not really important for MTO companies which need to maintain a traditional functional or process layout in order to offer the level of flexibility required by the product mix being manufactured. As described in section 9.5.1, where specific skills are often being sold, highly specialised machinery is often necessary to produce different products at any point in time. This is in contrast to the general literature that suggests companies should have simple movable/flexible machinery for all kinds of manufacturing environment (For instance see Schonberger (1996), Shores (1994), Morton (1994)).

10.3 Areas for further research

The following issues represent potentially interesting continuations to the present study:

- At the moment the 12 points of the SHEN model are not given in any particular priority order. Instead the model just identifies the set of issues. This is because it was felt that before a priority ranking could be found it is important to make sure that the list of possible improvements is comprehensive. Further research is needed to enable companies to determine which changes to make first and whether to make changes simultaneously or sequentially.
- It is essential that the model should be useable by companies without the need for expert interpretation. Thus, future research will also involve the investigation of

alternative methods of model presentation, including the possibility of using a workbook that can be used by company personnel to devise their own improvement programmes. In particular, such a workbook should provide some type of cost/benefit analysis so that companies can prioritise the various improvement options and allocate their limited resources to the best effect.

- The ideas developed so far have been addressed to SME MTOs. Further research is needed in order to examine the applicability of the approach to the larger size MTO firms. If the approach is to be implemented in these companies, investigations are required to establish whether a new model would be essential, or whether the existing SHEN model would meet the needs of the larger sized MTO firms.
- It is noted that the case studies chosen were in some ways a convenience sample in that they were all in the Northwest of England. Further studies using cases from greater geographical diversity may be helpful in improving/updating the model further. For example, it is the intention of the author that the SHEN model could be applied to MTO companies in Malaysia. If the model is to be implemented by these companies, future studies using cases from Malaysian MTO companies are required to confirm the model further. In particular, cultural issues need to be explored as these may affect the human resource principles such as those related to rewards, paying for suggestions scheme, housekeeping and so on.

REFERENCES

- Aaker, D.A., Kumar, V. and Day, G. S. (1995), *Marketing Research*, John Wiley and Sons Inc., New York.
- Abraham, Steven E. and Spencer, Michael S. (1998), "The legal limitations to self-directed work teams in production planning and control", *Production and Inventory Management Journal*, Vol. 39 No. 1, pp. 41-45.
- Abrahamson, M. (1983), *Social Research Methods*, Prentice Hall: Englewood Cliffs, New Jersey, USA.
- Allen R.E (1990), *The Concise Oxford Dictionary of Current English*, Oxford Clarendon Press, UK.
- Amaro, G., Hendry, L. and Kingsman, B. (1999), "Competitive advantage, customisation and new taxonomy for non make-to-stock companies", *International Journal of Operations & Production Management*, Vol. 19 No. 4, pp. 349-71.
- Anderson Consulting (1995), *Worldwide manufacturing Competitiveness Study: The Second Lean Enterprise Report*, Arthur Anderson & Co, UK.
- Anonymous (1996), "New Definition for SME's", *Management Services*, Vol. 40 No. 7, p. 4.
- Baar, A. (2000), "Startup targets small business", *Adweek*, Midwest Edition, Vol. 41 Is. 51, p 5.
- Badore, Nancy L. (1992), "Involvement and Empowerment: The modern paradigm for management success", in Heim, Joseph A and Compton W. Dale (Ed). *Manufacturing systems: foundations of world-class practice*, National Academy Press, Washington D.C.
- Baker, Michael J. (1991), *The Marketing Books (2nd Edition)*, Butterworth-Heinemann: Chartered Institute of Marketing, UK.
- Beasley, Gary and Cook, Joseph (1995), "The 'what,' 'why' and 'how' of benchmarking", *Agency sales*, Vol. 25 No. 6, pp. 52-55.
- Benbasat, I., Goldstein, D. and Meid, M. (1987), "The Case Research Strategy in Studies of Information System", *MIS Quarterly*, Vol. II, pp. 369-86.
- Benson, G. P., Saraph, J. V. and Schroeder, R. G (1991), "The effects of organisational context on quality management: an empirical investigation", *Management Science*, Vol. 37 No. 9, pp. 1107-24.

- Bergamaschi D., Cigolini R., Perona M. and Portioli A. (1997), "Order Review and release strategies in a job shop environment: a review and classification", *International Journal of Production Research*, Vol. 35 No. 2, pp. 399-420.
- Bonoma, Thomas V. (1985), "Case Research in Marketing Opportunities, Problems and a Process", *Journal of Marketing Research*, Vol. XXII, pp. 199.
- Bozarth, C.C., and Berry, W.L. (1997), "Measuring the congruence between market requirements and manufacturing: A methodology and illustration", *Decision Sciences*, Vol. 28 Is. 1, pp. 121-50.
- Brown S., Lamming R., Bessant J. and Jones P. (2000), *Strategic Operations Management*, Butterworth-Heinemann: Oxford.
- Burcher P. and Stevens K. (1996), "Measuring up to world class manufacturing", *Control*, Vol. 22 No. 1, pp. 17-21.
- Burton, Dawn (2000), "The use of Case Studies in Social Science Research", in Burton, Dawn (Ed). *Research Training for Social Scientists*, Sage Publications, London.
- Bryman, Alan (2001), *Social Research Methods*, Oxford University Press, Oxford.
- Chen, Frederick (1997), "Issues in the continuous improvement process for preventive maintenance: Observation from Honda, Nipondenso and Toyota", *Production and Inventory Management Journal*, Vol. 38 Is. 4, pp. 13-16.
- Cheng, T.C.E. (1988), "Integration of priority dispatching and due date assignment in a job shop", *International Journal of Systems Science*, Vol.19 No. 9, pp. 1813-25.
- Chetty, S. (1996), "The Case Study Method for Research in Small-and Medium-sized Firms", *International Small Business Journal (incorporating European Small Business Journal)*, Vol. 15 No. 1, pp. 73-83.
- Christy, D.P and Kanett, J.J (1990), "Manufacturing systems with forbidden early shipment: Implications for choice of scheduling rules", *International Journal of Production Research*, Vol. 28 No. 1, pp. 91-100.
- Clifford, J.P. (1999), "The collective wisdom of the workforce: Conversations with employees regarding performance evaluation", *Public Personnel Management*, Vol. 28, pp. 119-56.
- Compton, W. Dale; Dunlap, Michelle D. and Heim, Joseph A. (1992), "Improving Quality Through the Concept of Learning Curves", *Manufacturing systems: foundations of world-class practice*, National Academy Press, Washington D.C.
- Crosby, P. B. (1988), *The Eternally Successful Organisation*, McGraw-Hill, New York.

- Dawood, Nashwan N. (1995), "An integrated bidding management expert systems for the make-to-order precast industry", *Construction Management and Economics* Vol. 13 No. 2, 115-135.
- DeFilippo, J.S. (1997), "World-class manufacturing in Chengdu: a case study on China's first aviation joint venture", *International Journal Technology Management*, Vol. 13 No. 5/6, pp. 681-94.
- Deming, W. E (1986), *Quality, Productivity, and Competitive Position*, Center for Advance Engineering Study, MIT, Cambridge, MA.
- Deming, W. E. (1982), *Out of the Crisis*. MIT, Cambridge, Massachusetts, USA.
- Denzin, Norman K. (1970), *The Research Act: A Theoretical Introduction to Sociological Methods*, Chicago: Aldine, USA.
- Department of Trade & Industry (1990), *Managing the '90s – Manufacturing*.
- Department of Trade & Industry (1991), *Managing the '90s – Aiming for World Class Manufacturing*.
- Deshpande, S. P. and Damodar Y. G. (1994), "HRM practices in large and small manufacturing firms: a comparative study", *Journal of Small Business Management*, April, pp. 49-56.
- Drummond, Helga (1993), *The Quality Movement; What Total Quality Management is really all about*, Kogan Page, London.
- Easterby-Smith, M., Thorpe R. and Lowe, A. (1997), *Management Research, An Introduction*, Sage Publications, London.
- Eisenhardt, K.M. (1989), "Building Theories from Case Study", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-50.
- Feigenbaum, A.V. (1991), *Total Quality Control (3rd edition, revised)*, McGraw Hill, New York.
- Ferras, L. (1994), "Continuous Improvements in Electronics Manufacturing", *Production and Inventory Management Journal*, Vol. 35 Is. 2, pp. 1-5.
- Fielding, N. (1988), *Actions and Structure: Research Methods and Social Theory*, Sage: London.

- Fine C.F (1995), "Managing Quality: A Comparative Assessment". Manufacturing Issues, New York, Booz Allen and Hamilton. In Boaden, R.J., (1997). "What is Total Quality Management ... and does it matter?", *Total Quality Management*, Vol. 8 No. 4, pp. 153-71.
- Flynn B.B., Schroeder R.G., Flynn E.J., Sakakibara S. and Bates K.A. (1997), "World Class Manufacturing Project: Overview and selected results", *International Journal of Operations and Production Management*, Vol. 17 No 7, pp. 671-85.
- Gargeya, Vidyananya B. and Thompson, Jonathan P. (1994), "Just-in-time production in small job shops", *Industrial Management*, Vol. 36 No. 4, p. 23-30.
- Garsombke, T.W. and Garsombke, D.J. (1989), "Strategic Implications facing small manufacturers: The linkage between robotisation computerisation, automation and performance", *Journal of small business management*, Vol. 27 No. 4, pp. 34-44.
- Giffi, C., Roth, A. and Seal, G. (1990), *Competing in World Class Manufacturing: America's 21st Century Challenge*, Business One Irwin, Homewood, Illinois.
- Gill, J. and Johnson, P. (1997), *Research Methods for Managers 2nd Edition*, Paul Chapman Publishing Ltd., London.
- Grieco, Peter L. Jr. (1996), "World Class Customer", *Executive Excellence*, Vol. 13 No 2, pp. 10-11.
- Hammer M. and Champy J. (1993), *Re-engineering the Corporation*, Nicholas Brealey.
- Hammersley, M. and Atkinson, P. (1983), *Ethnography: Principles in Practice*, Tavistock: London, UK.
- Handfield R.B and Pannesi R.T. (1995), "Antecedents of leadtime competitiveness in make-to-order manufacturing firms", *International Journal of Production Research*, Vol. 33 No. 2, pp. 511-37.
- Hanson, W. C. (1992), "The Integrated Enterprise", in Heim, Joseph A and Compton W. Dale (Ed). *Manufacturing systems: foundations of world-class practice*, National Academy Press, Washington D.C.
- Hart, Norman A. (1990), *The Practice of Advertising (3rd. Edition)*, Heinemann Publishing: on behalf of Chartered Institute of Marketing, UK.
- Hayes, R.H., Wheelwright, S.C. and Clark, K.B. (1988), *Dynamic Manufacturing. Creating the learning organisation*, The Free Press, New York, NY.
- Hayes, R.H. and Clark K.B. (1986), "Why Some Factories Are More Productive than Others", *Harvard Business Review*, Vol. 64 No. 5, pp. 66-73.

- Heim, Joseph A. and Compton, W. Dale (1992), *Manufacturing systems: foundations of world-class practice*, National Academy Press, Washington D.C.
- Henderson, I., (2001), "Why is Making To Order so different?", *BPIC Control*, December/ January, pp. 19-23.
- Hendry L. C., Akhbar, N., Hucknall, C. and Walker, N., (1993), "Implementing Bar Coding- just jumping on a band wagon?", *BPICS Control*, April/May 1995, pp. 31-35.
- Hendry L.C. (1998), "Applying world class manufacturing to make-to-order companies: Problems and solutions", *International Journal of Operations and Production Management*, Vol. 18 No.11, pp. 1086-100.
- Hendry L.C., Wilson E., Kingsman B.G., Worden L. and Mercer A. (1993), "Integrating production planning in make-to-order companies", *Proceedings of the International Conference on Managing Integrated Manufacturing*, Keele, UK, pp. 427-436.
- Hendry L.C., Wilson E., Kingsman B.G., Worden L. and Mercer A. (1992), "Dynamic Planning of Resources for Make-To-Order companies", *Proceedings of the eighth International conference on Computer Aided Production Engineering*, Edinburgh, pp.159-65.
- Hendry, L.C, Kingsman, B.G. and Cheung, P (1998), "The effect of workload control (WLC) on performance in make-to-order companies", *Journal of Operations Management*, Vol. 16 Is. 1, pp. 63-75.
- Hendry, L.C. and Kingsman, B.G. (1989), "Production planning system and their applicability to make-to-order companies", *European Journal of Operation Research*, Vol. 40, pp. 1-15.
- Hill, T. (1993), *Manufacturing Strategy: The Strategic Management of the Manufacturing Function*, Macmillan; Basingstoke.
- Hill, T. (1995), *Manufacturing Strategy*, Macmillan; Basingstoke.
- Hodgetts, Richard M. (1996), World Class Manufacturing: The Next Decade (Book Review), *Organizational Dynamics*, pp. 88-89.
- Howard A., Kochhar A. and Dilworth J. (1998), "An objective approach for generating the functional specification of manufacturing planning and control system", *International Journal of Operations & Production Management*, Vol. 18 No 8, pp. 710-26.

- Hsu, Mei, and Chen, Been-Lon (2000), "Labor productivity of small and large manufacturing firms: The case of Taiwan", *Contemporary Economic Policy*, Vol. 18 No. 2, pp. 270-83.
- Huq, Ziaul and Huq, Faizul (1994), "Embedding JIT in MRP: The case of job shops", *Journal of Manufacturing Systems*, Vol.13 No 3, pp. 153 –64.
- Hurley, Simon F and Whybark D. Clay (1999), "Comparing JIT approaches in a manufacturing cell", *Production and Inventory Management Journal*, Vol. 40, Is 2, pp. 32-37.
- Hussey, Jill and Hussey, Roger (1997), *Business Research, A Practical Guide for Undergraduate and Postgraduate Students*, McMillan Press Ltd, London.
- Hutchings, Anthony F.and Knox, Steve T (1995), "Creating Products Customers Demand", *Association for Computing Machinery. Communications of the ACM*, Vol. 38 No 5, pp. 72 –80.
- Imai, M. (1986), *Kaizen: The Key to Japan's Competitive Success*, Mc-Graw Hill, New York.
- Industry week (2000), "Best Practices", January 24, pp. 47-57.
- Industry Week Census 1997, "World Class Manufacturers", December 1, 1997, pp. 44-47.
- Irani, Z., Sharp, J.M., and Race, P. (1997), "A case experience of new product introduction within a once-traditional subcontract manufacturing environment", *Production and Inventory Management Journal*, Vol. 38 Is. 2, pp. 47-48.
- Janesick, V. J. (1994), "The Dance of Qualitative Research Design" in Denzin N. K. and Lincoln Y. S. (Ed). *Handbook of Qualitative Research*, Sage Publications, London.
- Jick, Todd D. (1979), "Mixing Qualitative and Quantitative Methods: Triangulation in Action", *Administrative Sciences Quarterly*, Dec. 24, pp. 602-11.
- Jina J., Bhattacharya A. and Walton A. (1996), "Applying Lean Principles for High Product Variety and Low Volumes: Some Issues and Propositions", *Logistics Information Management*, Vol. 10 No. 1, pp. 5-13.
- Juran , J.M. (1989), *Juran on Leadership for Quality: an executive handbook*, The Free Press MacMillan, New York.
- Juran, J. M. (1981), "Product Quality: A Prescription for the West". *Management Review*, Vol. 70 No. 7, pp. 8-14.

- Juran, J. M. (1993), "Made in the USA: Renaissance in Quality". *Harvard Business Review*, pp 42-50.
- Kanter, Rosabeth M. (1995), *World Class: Thriving Locally in the Global Economy*, NY: Simon & Schuster
- Kingsman B.G, Hendry L.C., Wilson E., Worden L. and Mercer A. (1993), "Integrating marketing and production planning in make-to-order companies", *International Journal of Production Economics*, Vol. 30-31, pp. 53-56.
- Kingsman B.G., Hendry L.C., Mercer A. and De Souza A. (1996), "Responding to Customer Enquiries in Make-To-Order Companies: Problems and Solutions", *International Journal of Production Economics*, Vol. 46-47, pp. 219-31.
- Kingsman B.G., Worden L., Hendry L.C., Mercer A. and Wilson E., (1993), "Integrating Production Planning in Make-To-Order Companies", *Proceedings of International Conference on Managing Integrated Manufacturing*, Vol. 1, pp. 427-36.
- Knight, Gary (2000), "Entrepreneurship and marketing strategy: The SME under globalisation", *Journal of International Marketing*, Vol. 8 No. 2, pp.12-32.
- Kochhar A., and McGarrie B. (1992), " Identification of the Requirements of Manufacturing Control Systems: A Key Characteristics Approach", *Integrated Manufacturing Systems*, Vol. 3 No. 4, pp. 4-15.
- Kochhar A., and Suri A. (1992), "Gap Analysis Approach to the Effective Implementation of Master Production Scheduling Systems", *Integrated Manufacturing Systems*, Vol. 3 No 4, pp. 20-23.
- Kolb, D. A., Rubin, I.M. and McIntyre, J.M. (1979), *Organizational Psychology: An Experiential Approach*, Prentice-Hall, London.
- Kueng, Peter (2000), "Process performance measurement system: A tool to support process-based organisations", *Total Quality management*, Vol. 11 Iss. 1, pp. 67-85.
- Land M. and Gaalman G. (1996), "Workload control concepts in job shops: a critical assessment", *International Journal of Production Economics*, Vol. 46-7, pp. 534-548.
- Land M. and Gaalman G. (1998), "The performance of workload control concepts in job shops: improving the release method", *International Journal of Production Economics*, Vol. 56-7, pp. 347-364.

- Lau, R. S. M. (1996), "Strategic flexibility: A new reality for world-class manufacturing", *S.A.M. Advanced Management Journal*, Vol. 62 No 2, pp. 11-15.
- Lee, W.J. and Kim, D. (1993), "Optimal and Heuristic Decision Strategies for Integrated Production and marketing Planning", *Decision Sciences*, Vol. 24 Is. 6, pp. 1203-13.
- Liberatore, M. J. and Titus, G. J. (1986), "The use of computer controlled tools by small machine shops", *Journal of Small Business Management*, Vol. 24 No. 1, pp.55-62.
- Lingayat, S., Mittenthal, J., and O Keefe, R.M. (1995), "Order Release in Automated Manufacturing Systems", *Decision Sciences*, Vol. 26 Is. 2, pp. 175-207.
- Malayeff, J. (1997), "Proper use of capability indices", *Machine Design*, Vol. 69, Iss.6, pp. 73-78.
- Manufacturing Products & Services Ltd. (MAPS) (1995), *FOURMAN Product Overview*, West Yorkshire.
- Markland, Robert E., Vickery, Shawnee K. and Davis, Robert A. (1998), *Operations Management*, South-western College Publishing, USA.
- Marlow, S. and Dean P. (1993), "Managing the employment relationship in the small firm: possibilities for human resource management", *International Small Business Journal*, Vol. 11 No. 4, pp. 57-64.
- Martel, Marc C. (1993), "The role of just-in-time purchasing in Dynapert's transition", *Production and Inventory Management Journal*, Vol. 34 Is. 2, pp. 71-76.
- McClenahan, John S. (1999), "Global Judgements", *Industry Week*, Vol. 248, Iss. 15, pp. 92-94.
- Melynk S.A. and Ragatz, G.L. (1989), "Order review/release: Research issues and perspectives", *International Journal of Production Research*, Vol. 27 No. 7, pp. 1081-96.
- Morton C, (1994), *Becoming World Class*. Macmillan Press, UK.
- Neuman, W. L. (1997), *Social Research Methods, Qualitative and Quantitative Approach 3rd Edition*, Allyn and Bacon, MA, USA.
- Newman, Richard G. (1988), "Insuring Quality: Purchasing's Role", *International Journal of Purchasing and Materials Management*, Vol. 24, pp.14-21.

- Oakland, John S. (1993), *Total Quality Management: The route to improving performance*, Butterworth- Heinemann Ltd., UK.
- Oliver, N., Delbridge, R., Jones, D. and Lowe, J. (1994), "World class manufacturing: further evidence in the lean production debate", *British Journal of Management*, Vol. 5, special issue, pp. 53-63.
- Owen, Jean V. (1994), "Job shops fight the odds", *Manufacturing Engineering*, Vol. 113 No. 4, pp. 55-59.
- Philipoom, P.R., Malhotra M.K., and Jensen J.B. (1993), "An evaluation of Capacity Sensitive Order Review and Release Procedures in Job Shops", *Decision Sciences*, Vol. 24 Is. 6, pp. 1109-33.
- Philips, Paul and Appiah-Adu, Kwaku (1998), "Benchmarking to improve the strategic planning process in the hotel sector", *The Service Industries Journal*, Vol. 18 No. 1, pp. 1-17.
- Porter K. and Little D. (1996), "Finite Scheduling and MRP– Revealing relationships", *Control*, Vol. 22 No. 4, pp. 23-26.
- Prabhu, V., Yarrow, D. and Gordon-Hart, G. (2000), "Best practice and performance within Northeast manufacturing", *Total Quality Management*, Vol. 11 No.1, pp. 113-22.
- Ragatz, G.L. and Mabert V. A. (1988), "An evaluation of order release mechanisms in a job shop environment", *Decision Sciences*, Vol. 19 Is. 2, pp. 167-89.
- Ralston D. (1996), "A Brief History of Manufacturing Control Systems: A personal View of Where We Went Wrong: Part 4", *Control*, Vol. 22, No. 8, pp. 13-17.
- Revans R.W. (1983), *Developing Effective Managers*, Longman, London.
- Rietz, W., H. K. Tonshoff and M. A. Rotzoll (1997), Improvement of production structures using benchmarking. Proceedings of the first International conference on Managing Enterprises- Stakeholders, Engineering, Logistics, and Achievement (ME-SELA '97), Loughborough University, UK.
- Rishel, T. D. and Burns, O. M. (1997), "The impact of Technology on small manufacturing firms", *Journal of Small Business Management*, January, pp. 2-10.
- Sadler-Smith E., Sargeant A. and Dawson A. (1998), "Higher level skills training and SMEs", *International Small Business Journal*, Vol. 16 No. 2, pp. 84-94.
- Saunders, Mark, Lewis, Philip and Tornhill, Adrian (2000), *Research Methods for Business Students- 2nd Edition*, Pearson Education Ltd, UK.

- Schartner, Andreas and Pruett, James M. (1991), "Interactive Job Shop Scheduling: An Experiment", *Decision Sciences*, Vol. 22 Is. 5, pp. 1024-46.
- Schonberger R.J. (1986), *World Class Manufacturing: The Lessons of Simplicity Applied*, The Free Press, New York.
- Schonberger R.J. (1996), *World Class Manufacturing: The Next Decade*, The Free Press, New York.
- Shingo, Shigeo (1988), *Non-stock production: the Shingo system for continuous improvement*, Cambridge, Mass.
- Shores, Richard A. (1994), *Reengineering the factory: A primer for world class manufacturing*. ASQC Quality Press, Milwaukee, Wisconsin.
- Sousa, R. and Voss C.A. (1999), "Linking manufacturing strategy and best practice: An empirical investigation of quality management", *Proceedings from Managing Operations Networks EurOMA Conference*, Venice, Italy.
- Spencer, Michael S. (1994), "Production planning in make-to-order repetitive environment", *Production Planning & Control*, Vol. 5 No 6, pp. 575-84.
- Steiner M. P. and Solef, O. (1988), "Factor for success in small manufacturing firms", *Journal of Small Business Management*, Vol. 26 No. 1, pp. 51-56.
- Stimpert J L. (1997), "World Class Manufacturing: The Next Decade", *Academy of Management*. The Academy of Management Review, Mississippi State (Book Review), pp. 805-09.
- Strauss, A., Corbin, J. (1990), *Basics of Qualitative Research*, Sage Publication: Newbury Park, CA.
- Teague, Paul E., Bak, David J., Puttre, Michael and Fitzgerald, Kevin R. (1997), "Suppliers: The competitive edge in design", *Purchasing*, Vol. 122 No 7, pp. 32S5-32S23.
- The New Webster Encyclopedic Dictionary of the English Language*, 1997, Random House Value Publishing, NY.
- Tobin, N., Mercer, A. and Kingsman, B.G. (1988), "A study of small subcontracting and Make-to-order firms in relation to quotation for orders", *International Journal of Operations and Production Management*, Vol. 6, pp. 46-59.
- Todd, Jim (1995), *World Class Manufacturing*, McGraw Hill International, UK.

- Vaughan, Diane (1992), "Theory elaboration: the heuristics of case analysis". In *What is a case? Exploring the foundation of social inquiry*, edited by Charles Ragin and Howard S. Becker, Cambridge: Cambridge University Press, pp. 173-202.
- Voss C. A., Ahlstrom P. and Blackmon K. (1997), "Benchmarking and operational performance: some empirical results", *International Journal of Operations & Production Management*, Vol. 17 No 10, pp. 1046-58.
- Voss C. and Blackmon K. (1996), "The impact of national and parent company origin on world class manufacturing", *International Journal of Operations and Production Management*, vol. 16, no 11, pp. 98-115.
- Wakao, Y. (1995), "Review of Quality maintenance and Important Models from Practice of Japanese Quality Control", Working Paper 95/17. *Management Science. Theory and Practice Series*, Vol. 2 No. 3, pp. 37-50.
- Womack, J., Jones D. and Roos D. (1990), *The machine that changed the world*, Rawson Assoc., USA.
- Yin, R. K., (1993), *Applications of Case Study Research, Applied Social Research Methods Series*, Vol. 34, Sage Publications, London.
- Yusof, S. M. and Aspinwall, A. (2000), "Total Quality Management Implementation Frameworks: Comparison and Review", *Total Quality Management*, Vol. 11, Iss.3, pp. 281-89.
- Zäpfel G. and Missbauer H. (1993), "New concepts for production planning and control", *European Journal of Operational Research*, Vol. 67 No. 3, pp 297-320.

APPENDIX 1:

***QUESTIONNAIRES USED TO COLLECT CASE STUDY
DATA***

QUESTIONS FOR MANAGEMENT LEVEL

1) The company.

- I. Can you please describe your main products?
- II. Who is the owner of the company?
- III. What is the approximate number of employees on site?
- IV. What is the approximate size (in million £) of your business at this site?
 ➤ Turnover £ _____ Net Asset £ _____
- V. Who are your main competitors?
 ➤ Regional _____ UK only _____. Global _____. Mixture _____.
- VI. What is your market position compared to your major competitors?
 ➤ The market leader; In the top 3; In the top 5; In the top 10; In the top 20; Others _____.
 Don't know _____.
- VII. How old is your company? Established _____.
- VIII. Where are your customers located?
 ➤ Regional _____ UK only _____. Global _____. Mixture _____.
- IX. Which of the following best describes your company area of manufacturing?
 (If more than one, please state the percentage of each)
- | | Tick | % |
|--|------|-------|
| ➤ Pure customisation – Producing new design. | () | _____ |
| ➤ Tailored Customisation – Modification of basic/existing design to customer needs or specification. | () | _____ |
| ➤ Standardised customisation – Pick from set of design options. | () | _____ |
| ➤ None – Take existing design as is. | () | _____ |
- X. Who is responsible for the following task? The company or the customer?
- Design (_____)
- Specifications (_____)
- Purchasing (_____).

2). Customers

- I. Approximately how many customers does the company have?
- II. How does the company maintain its relationship with customers? (i.e personal contact).

3). Enquiry.

- I. Can you describe the overall processes of responding to a customer enquiry?
- II. How long does it take to respond to a customer enquiry?
- III. Do you think this time is acceptable or should it be reduced?
- IV. Have you reduced it in recent years?

4). Orders.

- I. Who determines order priorities?
- II. On what is the decision on priority usually based?

5). Suppliers

- I. How many suppliers do you have? On average how many suppliers does the company use for each customer?
- II. Do you aim to cut your number of suppliers. If so, have you achieved this?

6). Product Design.

- I. Who does the design for a new product?
- II. Who else is involved in the design?
- III. Can you describe the process of designing the products?
- IV. To what extent does your company make use of computer databases in the design process? (re use design)

7). Shop floor information.

- I. Could you please tell me about the company storage system for work in progress, raw material and final products?
- II. Where do you store each type?
- III. How would you describe the degree of employee participation in your company towards the self-cleaning improvement/housekeeping?
- IV. Do you often experience delays in the arrival of raw materials or components or sub-assemblies on the shop floor?

8). Rewards and pay.

- I. What sort of training has been given to employees to improve their skills?
- II. In what ways does the company motivate workers?
- III. How does your company show recognition to the employees for improved performance?
- IV. On what is the evaluation of their performances usually based?

9). Quality program.

- I. Has there been any quality improvement initiatives in this company?
- II. Start-up of quality improvement;
 - How was the quality improvement initially embarked upon in your company?
 - Who actually was responsible for the improvement? (i.e. managers/employees).
 - How was the “quality awareness program” distributed/ implemented in the company?
 - What sort of training has been given to employees?
- III. Value (Value for money).
 - Have you heard about the new concept “value” for money?
(Explain).

10). Performance measurement.

- I. How does your company review customer satisfaction?
- II. Does the company gather any data about the customer-needs? What about other data? Any kinds of data.
- III. In what ways does your company benchmark?
- IV. Your measurement on company performance is usually based on what? (You may have more than one answer)
 - 1. Problem solving in the workplace ()
 - 2. Achievement (i.e defect rate, rework) ()
 - 3. Productivity, sales growth ()
 - 4. Profit. ()
- V. Are there any other measurements used previously but no longer used? (If yes, why you have stopped using them?)
- VI. How do you display/communicate the company performance with employees? (i.e meetings, display problem solving data, wall charts, etc.)
- VII. How frequent does this company summarize and display the results to employees or the public? (i.e weekly, monthly, etc.)
 - 1. Problem solving in the workplace (e.g. pareto chart) _____
 - 2. Achievement (i.e defect rate, rework) _____
 - 3. Productivity, sales growth _____
 - 4. Profit. _____

11). Machinery.

- I. How many machines does your company have?
- II. Can you describe the function of these machines?
- III. Which machines are often used. NC or CNC machines? Why?
- IV. How flexible are the machines, can they be moved around if necessary?

12). Maintenance.

- I. Who does the machine set up?
- II. What will be your action when there is a breakdown?
- III. Do you aim to cut the number of breakdowns? If so, how and have you achieved this?

13). Information flow.

- I. What mechanisms do you have for communication between management and shop floor workers?
- II. Do the company have a manual system such as a planning board/work to list or any package to ease the information flow?
- III. To what extent does your company make use of a computer to cut the internal transactions? (i.e. filing, employees record, salary, purchasing etc.)
- IV. How often do you use a fax machine when dealing with your customer?

14). Promotion.

- I. What kind of advertisement is used?
- II. Do you think it is appropriate to the target customers?
- III. Have the company received any form of certification?

15). Company's planning.

- I. What is the mission of the company?
- II. Who decides the mission in this company?

QUESTIONS FOR EMPLOYEES

1). Workers information. (Employed workers are asked to provide a job description of their present occupation).

- I. What kind of work do you do?
- II. What is your main occupation called?
- III. Tell me a little about what you actually do in that job?
- IV. What are some of your main duties?
- V. Have you been trained how to do your job effectively?
- VI. How long have you been involved with this job?
- VII. How many machines do you operate?
- VIII. Who does the machine repairs?
- IX. How would you describe the frequency of your communication with the management?
➤ Often_____. Sometimes_____. Rare_____. None_____.
- X. Are you satisfied with your career at this company?

2). Shop floor information.

- I. How do you sequence your jobs?
- II. How do you determine order priorities?
- III. Do you aim to cut flow time? If so, have you achieved this?
- IV. Have you been given any training regarding this matter?
- V. To what extent does your company make use of computerized databases (scheduling/workload control) in its operational processes?

3). Machinery and maintenance.

- I. Which machines are often used? NC or CNC machines? Why?
- II. How do you set up/changeover the machines?
- III. What will you do when there is a minor breakdown? What about a major breakdown?
- IV. Do you aim to cut the number of breakdowns? If so, how and have you achieved this?

4). Information flow

- I. Where can you find information about quality in this company?
- II. Where can you find information about cost, orders, and delivery in the company? Is it easy to access?

5). Promotion.

- I. Are you aware of any kind of promotional activities by this company?

6). *Company's planning.*

- I. Have you been informed about the company's goal?
- II. Can you easily access any information or records? Or does the company consider it as confidential?
- III. Are you encouraged to make suggestions to the management? If so, how?

APPENDIX 2:
SUMMARY OF LEVELS ACHIEVED BY THE SIX
COMPANIES

Table A2.1: Summary of the case study evidence for Principle 1.

Principle 1: *Integrate the functions of production and marketing in all processes.*

Steps	Step 1		Step 2		Step 3			Step 4		Step 5		Levels achieved				
	Description	Initial understanding between production and marketing;	Production and marketing functions work together in responding to customer enquiries;	Having a systematic data base system to enable MTO companies to respond to customer enquiries;	Achieve 50% reduction in time to respond to customer enquiries;	Understanding its competitors and having a systematic method for calculating price and delivery lead-time (i.e. strike rate matrix).										
Company	Same floor	Easy to communicate	Exchange of ideas	Dependant on each other	Manual	Excel	Other software	Achieve >20%	Achieve ≥50%	1	2	3	4	5		
A	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		
B	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		
C	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		
D	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		
E	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		
F	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		

Table A2.2: Summary of the case study evidence for Principle 2.

Principle 2: Design for products, processes and improved supplier relationships

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Train employees in understanding all the product specifications, product design rework and purchasing process/ knowing their suppliers;	Having a computerised design database with designs that can be altered for new orders;	Having a minimum number of parts, forgings or suppliers for each product;	Achieve 30% "repeated business" which makes it possible to establish partnership with some of the suppliers;	Achieve 50% "repeated business".	
Company		Insert data manually	Email link/ directly modified			1 2 3 4 5
A	✓	✓	✓			✓
B	✓	✓	✓	✓	✓	✓
C	✓	✓	✓	✓	✓	✓
D	✓	✓	✓	✓	✓	✓
E	✓	✓	✓	✓	✓	✓
F	✓	✓	✓	✓	✓	✓

Table A2.3: Summary of the case study evidence for Principle 3

Principle 3: Collaborate with customers

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Having good communication among employees, a common understanding of organisational objectives and customers needs.	Establish a personal relationship between employees and customers.	Getting customer representatives on the project.	Company helping the customers define their needs into product specifications and design.	Helping the customers meet their goals, rather than providing customer's wants.	
Company		Agent				1 2 3 4 5
A	✓	✓		✓		✓
B				✓		✓
C				✓		✓
D	✓			✓		✓
E		Top mgt or sales		✓		✓
F		✓		✓	✓	✓

Note: ✓* - Director/manager level only

Table A2.4: Summary of the case study evidence for Principle 4

Principle 4: Simplify the shop floor

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Improve visibility, use simple storage systems to reduce search times;	Improve locations of raw materials, WIP etc. to cut distances for movement of materials and tools;	Train shop floor employees on the importance of using the storage systems and of taking responsibility for their own housekeeping;	Implement housekeeping so that work areas are clean as well as ensuring that the storage systems are properly used;	The operator takes over his own housekeeping.	
Company						1 2 3 4 5
A	✓					✓
B	✓					✓
C	✓	✓	✓	✓	✓	✓
D	✓		✓	✓	✓	✓
E	✓		✓	✓	✓	✓
F	✓		✓	✓	✓	✓

Table A2.5: Summary of the case study evidence for Principle 5

Principle 5: *Seek simple, flexible, movable, low-cost equipment in multiples*

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Establish a policy to purchase and maintain equipment as required to meet goals;	30% of equipment is highly flexible/movable;	50% of equipment is highly flexible/movable;	80% of the equipment is highly flexible/movable;	99% of the equipment is highly flexible/ movable.	
Company	Manual machine CNC or equivalent					1 2 3 4 5
A	✓	✓	✓	✓		✓ ✓ ✓ ✓ ✓
B	✓	✓	✓	✓		✓ ✓ ✓ ✓ ✓
C	✓	✓	✓	✓		✓ ✓ ✓ ✓ ✓
D	✓	✓				✓ ✓ ✓ ✓ ✓
E	✓	✓				✓ ✓ ✓ ✓ ✓
F	✓	✓	✓	✓		✓ ✓ ✓ ✓ ✓

Table A2.6: Summary of the case study evidence for Principle 6

Principle 6: *Improve scheduling and workload control to cut flow times.*

Steps	Step 1 Train associates in readiness on job shop sequencing, queuing limitation, workload control, handling priority;	Step 2			Step 3 Having a computerised database system for scheduling/workload control;	Step 4 Achieving average reduction of flow time by 30%;	Step 5 Achieving average reduction of flow time by 50%.	Levels achieved				
		Having a practical, simple and easily implemented workload control or scheduling system;	Manual/By hand	Charts/computer print out				1	2	3	4	5
Company		Personal experience						1	2	3	4	5
A	✓	✓		Charts/computer print out ✓				✓				
B	✓	✓		Charts/computer print out ✓				✓	✓			
C	✓	✓	✓	Charts/computer print out ✓	✓			✓	✓			
D	✓	✓		Charts/computer print out ✓	✓			✓	✓	✓		
E	✓	✓		Charts/computer print out ✓				✓	✓			
F	✓	✓	✓	Charts/computer print out ✓				✓	✓			

Table A2.7: Summary of the case study evidence for Principle 7

Principle 7: Cut the start up/ changeover time and improve preventive maintenance.

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Train associates in set-up/changeover reduction and basic preventive maintenance;	Achieving 20% average reduction in set-up/changeover time;	Operators can take over their own preventive maintenance;	Achieving 30% average reduction in set-up/changeover time;	Employees achieve 50% reductions in set-up/changeover time across all processes.	
Company						
A	✓		✓			1 ✓
B	✓		✓			2 ✓
C	✓		✓			3 ✓
D	✓		✓			4 ✓
E	✓	✓	✓	✓		1 ✓ 2 ✓ 3 ✓ 4 ✓ 5 ✓
F	✓		✓			1 ✓ 2 ✓ 3 ✓ 4 ✓ 5 ✓

Table A2.8: Summary of the case study evidence for Principle 8

Principle 8: Improve information flow.

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Job priorities are clearly understood by all and everyone is working to the same plan;	Having a systematic methods to communicate the plan to include manual systems such as a planning board or 'work to lists' produced by an appropriate software package;	Having information about quality, cost, orders, delivery, and design that is readily available anytime to all in the factory;	Workflow, internal quality, internal scheduling and labour transactions cut by 25%;	Internal transactions cut by 50% and 50% of external transactions are done by fax/ Internet/ EDI.	
Company	Follow the list given	Operator can make decision				1 2 3 4 5
A	✓			✓	✓	✓ ✓ ✓
B	✓		✓	✓	✓	✓ ✓ ✓
C	✓	✓	✓	✓	✓	✓ ✓ ✓
D	✓		✓	✓	✓	✓ ✓ ✓
E	✓		✓	✓	✓	✓ ✓ ✓
F	✓		✓	✓	✓	✓ ✓ ✓

Table A2.9: Summary of the case study evidence for Principle 9

Principle 9: Make rapid improvements in skills and flexibility.

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Implement a training programme for all associates to increase relevant skills;	80% of associates are flexible in skills and able to work on any machine;	99% of associates are flexible in skills and able to work on any machine;	Experts teach operators to do repairs; downtime cut by 50%;	Operators become technicians; downtime cut by 80%.	
Company		Some degree of flexibility	Total flexibility			1 2 3 4 5
A	✓		✓	✓	✓	✓
B	✓	✓		✓		✓
C	✓	✓				✓
D	✓	✓				✓
E	✓	✓				✓
F	✓	✓				✓

Table A2.10: Summary of the case study evidence for Principle 10

Principle 10: *Have systematic rewards, recognition and monetary payment.*

Steps	Step 1	Step 2	Step 3		Step 4	Step 5	Levels achieved
Description	Having a systematic performance appraisal system;	Systematic public recognition/celebration of achievement;	Variety of low-cost awards to both teams and individuals;		The company is investing in employees via training, cross training, cross careering;	The company reward for skills/knowledge; team/unit bonuses.	
Company		Newsletter	No cost award	Low cost award			1 2 3 4 5
A							
B							
C			✓	✓			
D		✓					
E							✓
F							✓

Table A2.11: Summary of the case study evidence for Principle 11

Principle 11: Everybody involved in change and strategic planning – to achieve a unified purpose

Steps Description	Step 1 Having strategic planning;		Step 2 Sharing information and records with shop floor employees;	Step 3 The frontline employees/teams /supervisors use process analysis, plot trends;	Step 4 Encourage employees to make suggestions to improve the process;	Step 5 The company gains the involvement and commitment of customers in their strategic plan.	Levels achieved					
	Unwritten / informal	Written	Partial	All	Encourage suggestions	Paying for suggestions	1	2	3	4	5	
Company												
A	✓		✓*			✓						
B						✓						
C			✓			✓						
D		✓	✓									
E		✓	✓									
F	✓					✓						

Note: ✓* - key personnel only

Table A2.12: Summary of the case study evidence for Principle 12

Principle 12: Improve quality and implement appropriate performance measures

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Establish a culture that supports continuous improvement in all processes;	Practice the principles of quality;	Training in universal customer wants: speed, flexibility, quality or value (QSFV);	QSFV are dominant performance measures;	Second order performance measures (e.g. labour productivity) no longer managed.	
Company						1 2 3 4 5
A		✓	✓			✓
B		✓	✓			✓
C		✓	✓			✓
D	✓	✓	✓	✓		✓
E		✓	✓	✓		✓
F		✓	✓	✓		✓

Table A2.13: Summary of the case study evidence for Principle 13

Principle 13: Gather customer feedback and benchmarking

Steps	Step 1	Step 2	Step 3	Step 4	Step 5	Levels achieved						
Description	Gathering customer-satisfaction data, review complaints and make continuous improvement on products and services;	Gathering customer-needs data;	Gathering competitive samples and best practice data;	All associates involved in customer/competitive best practice;	The company implement full-scale benchmarking for its processes.							
Company	<table border="1"> <tr> <td>Informal</td> <td>Formal with some data</td> </tr> </table>	Informal	Formal with some data	<table border="1"> <tr> <td>Informal</td> <td>Formal with some data</td> </tr> </table>	Informal	Formal with some data	<table border="1"> <tr> <td>Informal</td> <td>Formal with some data</td> </tr> </table>	Informal	Formal with some data			1 2 3 4 5
Informal	Formal with some data											
Informal	Formal with some data											
Informal	Formal with some data											
A	✓					✓						
B	✓					✓						
C	✓	✓				✓						
D	✓	✓				✓						
E	✓					✓						
F	✓	✓				✓						

Table A2.14: *Summary of the case study evidence for Principle 14*

Principle 14: *Promote/market/sell every improvement*

Steps	Step 1		Step 2	Step 3	Step 4	Step 5	Levels achieved
Description	Having good advertisements with effective placing (newspaper, magazine, etc.) for the target customers;		Positive QSFV trends featured in selling, bids, proposals, ads;	Registration; certifications; local awards (ISO-9000, Ford Q1, state award);	Global/national awards (e.g., Baldridge);	Reverse marketing: Out of strength, you choose whom you sell to.	
Company	Recommendation & phones	Magazine, Newspaper brochures etc.	WWW pages etc.				1 2 3 4 5
A	✓	✓		✓			✓
B	✓	✓		✓			✓
C	✓	✓		✓	✓		✓
D	✓	✓	✓	✓			✓
E	✓	✓	✓	✓	✓		✓
F	✓	✓	✓	✓	✓		✓