MANUFACTURING STRATEGY :

DEVELOPMENTS IN APPROACH AND ANALYSIS

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CONTENTS

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TITLE : MANUFACTURING STRATEGY : DEVELOPMENTS IN APPROACH AND ANALYSIS

For established manufacturing nations, increased competitive pressure has been the way of life since the late 1970s. For the most part however, production decision making in manufacturing industry has not changed to meet these new challenges. It usually takes a subordinate strategic role to the marketing and finance functions with the consequence that it accepts a reactive role in the corporate debate.

The outcome is that strategic initiatives and developments are predominantly based on corporate marketing-decisions at the "front end" with manufacturing being forced to react at the "back end" of the debate. Since manufacturing managers come late into these discussions, it is difficult for them to successfully influence corporate decisions. All too often, the result is the formulation and later development of strategies which manufacturing is unable to successfully support. That is not to say that this happens for want of trying - strong is the work ethic in the manufacturing culture. However, if the basic link between the manufacturing processes and infrastructure (ie manufacturing strategy) and the market is not strategically sound, then the business will suffer.

There are many reasons why manufacturing is typically reactive in the strategic debate. One important factor is the lack of appropriate concepts and language with which to explain or contribute to corporate decisions. This research has been undertaken to help redress this deficiency.

The work began in the early 1980s. Upto that time, both the professional and academic contributions to the field of manufacturing strategy principally concerned statements which highlighted the problem and alerted manufacturing industry as a whole to its size and potential. However, there were in addition some important early pointers as to ways of overcoming the inadequacy of production's contribution to strategy formulation as well as some alternative approaches which firms needed to consider as ways of improving their overall performance. The inability of the production executive to contribute appropriate functional inputs provided the stimulus to undertake this work and to endeavour to build on initial insights as a way of taking forward the subject area of manufacturing strategy.

The core of this thesis concerns these developments. Reported here are three contributions to this field of study all of which have been tested in different firms and are increasingly being used by academics, consultants and businesses as a way of helping to gain essential insights into what is a complex problem.

The three facets are:

- Typically, corporate strategies are composites of functional statements which are inadequately debated one with another in order to understand and test the coherence of the approaches proposed. The result is that the opportunity to fashion corporate strategies supported by all the functions within a business is not adequately pursued. In addition, the necessity to develop corporate strategy in this way and the advantages which ensue have gone unrecognised

- The reactive role of manufacturing results in a lack of strategic direction within this function. As a result, typical developments and investments tend to take the form of operational responses undertaken without strategic context. One outcome of the research is a methodology which provides a way in which a business can develop a manufacturing strategy which links manufacturing developments and investments to the needs of its agreed markets. Two applications of this are provided in Chapter 4

- It is most important for an industrial company to recognise that it is attempting to support the inherently changing nature of its markets with manufacturing investments the characteristics of which are fixed in nature and will not change without further investments and developments. Product profiling is a methodology for enabling companies to assess the current level of match between its markets and manufacturing and to recognise the extent to which decisions will effect this in the future. Examples of its application illustrating different sources of mismatch are given in Chapter 5

1 INTRODUCTION

The research reported here was undertaken in the 1980s. During that time the whole area of manufacturing strategy was developing and changing rapidly. The work completed in this period was, therefore, in parallel with these changes and designed to be of practical value in the development of a manufacturing strategy for a business. It concerns the provision of a conceptual base and the detailing of practical ways for businesses to increase the degree of match between manufacturing process and infrastructure developments and investments, and the corporate marketing decisions taken within a company. This would not only lead to helping the production function play its rightful part in developing corporate strategies, but would also improve a company's strategic outcomes as a consequence.

Given the increasingly competitive pressures since the early 1970s, companies, in order to succeed, have needed and will continue to need to harness all their strengths and capabilities and then give them coherent and appropriate strategic direction. One function which has tended to do this inadequately is manufacturing and this research has been directed at trying to improve this function's strategic contribution.

In order to help explain the rationale of the research approach adopted, the thesis is written to follow the sequence of the research itself. This first chapter is designed to set the scene.* It includes statements on relative manufacturing performance, offers views on why some nations have outperformed others, explains the reasons for the research and concludes with a statement on research objectives.

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* Here, as throughout the thesis, many statements and examples are drawn from my published work to date, a principle allowed for in the University of Warwick's regulations

Chapter 2 is a literature review which, in order to provide sequence, covers the period upto and including the start of the research and so helps to explain the position at the beginning. However, in order to map the parallel developments of other researchers in the 1980s, a review of their work is provided at the start of Chapter 4.

Chapter 3 deals with the research methodology used, while Chapters 4 and 5 overview some of the principal research findings. The final chapter is a short summary and presents my concluding statements.

1.1 THE ISSUES ADDRESSED IN THE THESIS WITHIN THE CONTEXT OF MY OVERALL MANUFACTURING STRATEGY RESEARCH FINDINGS

As explained in the opening paragraph, the research reported in this thesis was undertaken during the 1980s. It is opportune to also explain that during this time I published several major statements within this field which covered aspects of manufacturing strategy development not addressed in this thesis. Many of my articles and books are referenced appropriately in the pages which follow. However, it seems relevant to provide a short review of some of these to give context in terms of the whole of my research activity within the field of manufacturing strategy.

1.11 SELECTED PAPERS

My early statements were made in various papers. Two initial papers (1980 and 1983a) reported developments in methodology. They contained early developments of the framework which reviews the principle of linkage between marketing and manufacturing through a shared understanding of the markets in which a particular business competes. This aspect of my research forms one of the two areas which are addrssed in the chapters which follow.

An important development in manufacturing strategy (and one not covered in this thesis) concerns the concept of focus. An initial contribution to this aspect was made in a jointly written paper (1983b). This built on the earlier work of others and emphasised the evolving nature of manufacturing's support for a company's chosen markets.

1.12 BOOKS

My principal contribution to the field of manufacturing strategy has been made in the two books published since the mid 1980s (1985 and 1989). Whilst addressing the selected issues within this thesis they also report research findings in other key areas in manufacturing strategy including focus, process positioning and infrastructure developments.

The first book collected the various concepts and methodologies which I had identified in the period upto the mid-1980s. In that way it provided a comprehensive review of the principal ideas and developments which I had made upto that time. Of the two areas of research reported in detail in this thesis, the methdology used to develop a manufacturing strategy was, by this time, a well-formulated contribution to the field of manufacturing strategy and one which was fully documanted in this book. The second area reported in this thesis is that of product profiling. By the time of writing the 1985 book, the conceptual base for this approach was established but, as later research revealed, not fully explored.

The 1989 book, as would be expected, represented my thinking and research a few years on. The methodology for developing a manufacturing strategy had, by that time, been refined. Further ways to help to more clearly understand markets had been identified (for example, order-losing, sensitive qualifiers) and were reported here. The developments to the concept of product profiling were clearly marked as these outcomes of my research now warranted a chapter on their own.

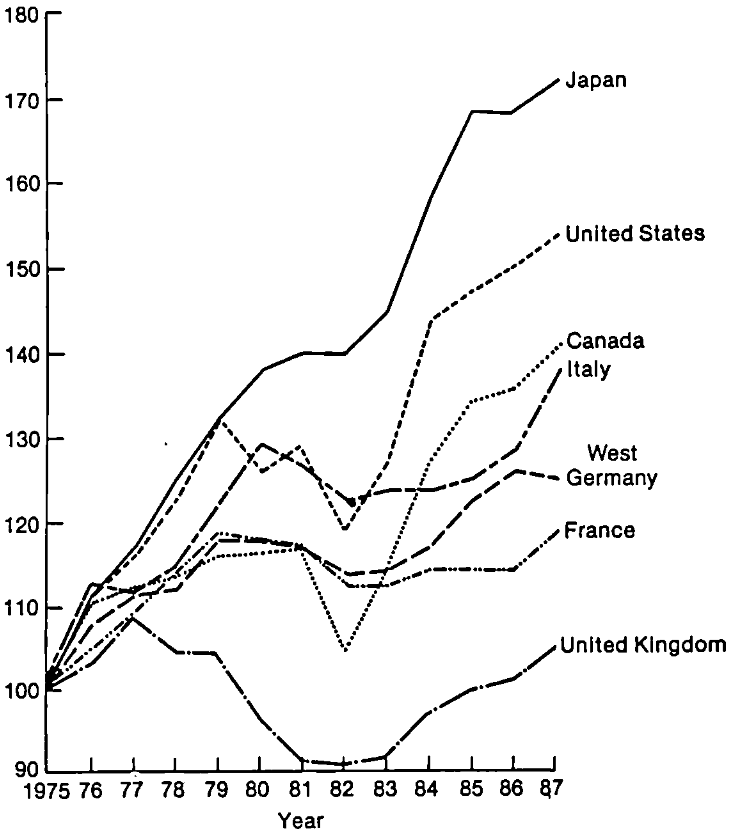
1.2 NATIONAL AND INTERNATIONAL COMPARISONS

The year 1984, for so long the centre of attention created by Orwell's forecast of the future, symbolised a new stark reality - the significant impact of industrial competition. This chapter provides some national and international comparisons. It shows how some nations with strong industrial traditions have come to be outperformed, consistently and over a long period of time. For the UK, the outcome has been significant.

1.21 MANUFACTURING OUTPUT

The UK's position as a leading manufacturing nation was never in doubt for over 200 years. However, as shown in Figure 1.1 since the mid 1970s it has fallen consistently behind its major competitors in terms of manufacturing output.

To shed further light on these differences, Table 1.1 gives the percentage share for some of the principal manufacturing countries' exports of manufacturing goods during the years 1969-87. On the whole, this reinforces the main message in Figure 1.1. It illustrates the consistent improvement in the manufacturing sector showing of some countries (for example Japan) and the strong and continued performance of others throughout the period (notably, West Germany, France and Italy). In the same period, however, the UK's twenty-nine point decline is only matched by the USA.



NOTE: 1987 figures are based on quarters one to three except for France, Italy, and West Germany, which are based on quarters one and two only.

Source: OECD indicators of industrial activity for 1979, 1983, 1985, and 1987.

Figure 1.1 Comparative Manufacturing Output 1975-87 (1975 = 100)

	Percentage Share of Total						
Year	*U.S.*	*Canada*	*France*	*Italy*	*Japan*	*U.K.*	*West Germany*
1969	19.2	6.3	8.2	7.3	11.2	11.2	19.1
1974	17.0	4.5	9.2	6.8	14.4	8.8	21.6
1979	16.0	4.2	10.5	8.4	13.7	9.1	20.8
1980	17.0	4.0	10.0	7.9	14.9	9.7	19.9
1981	18.6	4.6	9.2	7.7	17.9	8.5	18.4
1982	17.7	4.9	9.2	8.0	17.4	8.5	19.5
1983	16.9	5.5	8.9	8.1	18.5	7.9	19.0
1984	17.2	6.3	8.6	7.7	20.1	7.6	18.1
1985	16.5	6.2	8.5	7.8	19.7	7.9	18.7
1986	14.0	5.4	8.8	8.2	19.4	7.6	10.7
1987	13.7	4.9	9.1	8.2	17.9	7.9	21.5
+ or − percent change.[2]	−28.6	−22.2	11.0	12.3	59.8	−29.5	9.7

1. The figures for 1987 are based on Quarters 1 and 2 only.
2. + or − percent change is the difference between 1969 and 1987, as a percentage of 1969.
3. Included in the definition of main manufacturing countries, but not listed here, are Belgium, Luxembourg, Netherlands, Sweden, and Switzerland.

Source: Monthly Review of External Trade Statistics. Department of Trade and Industry (U.K.). Issue no. 145, January 88, Table E2.

Table 1.1 Main Manufacturing Countries' Percentage Share of the Total Manufactured Goods Exported from these Selected Countries

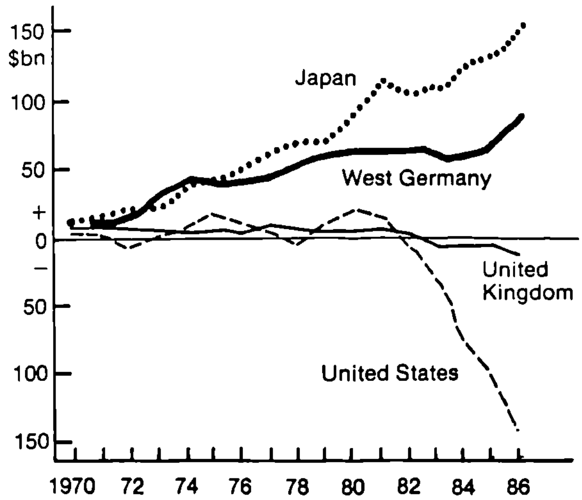
To complete this initial review, the export-import trade ratios of manufacturing industry within selected countries provides an insight into the relative performance of the major world competitors (see Table 1.2).

Country	Export-import ratio, total manufacturing industries	
	1972	1982
Canada	0.9	1.1
France	1.1	1.0
Italy	1.3	1.3
Japan	2.8	3.0
United Kingdom	1.1	0.9
United States	0.8	0.9
West Germany	1.5	1.5

Source: OECD Science and Technology Indicators Unit, *Newsletter No. 8* (1984) pp. 6, 7.

Table 1.2 Export/Import Ratios of Trade for Total Manufacturing Industries, 1972 and 1982

The figures reinforce the strong position held by Japan and West Germany and the absolute decline in the UK performance. The year 1983 witnessed the culmination of these trends when, for the first time in over 200 years in fact, since the Industrial Revolution, the UK became a net importer of manufactured goods. This trade balance has remained firmly in deficit ever since (see Figure 1.2), with the UK incurring £20bn deficit in 1989.



Source: OECD

Figure 1.2 Trends in the Balance of Manufacturing Trade for Selected Industrial Nations

The decline in the UK's competitive position in the world industrial markets is there for all to see. Loss of market share abroad, increased imports at home. UK industry has performed badly for a long time, whatever measure is used. A more in-depth review of her trading performance confirms the picture. It shows that from 1973, imports took an increasing market share for manufactured goods overall whilst making significant and very worrying inroads into certain sectors - see Table 1.3.

Manufacturing sector	Imports/home demand ratio 1973	1979	1980	1981	1982	1983	1983 (1973=100)
Motor vehicles and their parts	23	41	39	42	46	51	222
Paper, printing and publishing	19	19	19	20	20	20	105
Engineering							
mechanical	26	29	29	32	32	36	138
electrical and electronic	27	31	31	36	40	43	159
instruments	46	53	52	55	56	56	122
Chemicals and man-made fibres	22	30	29	31	34	33	150
Food, drink and tobacco	19	18	16	16	16	17	89
Textile industry	21	33	34	39	39	41	195
Clothing and footwear	18	29	29	33	33	34	189
Total manufacturing industry	21	27	26	28	29	31	148

Source: Central Statistical Office (CSO), *Annual Abstract of Statistics*, Table 12.1 'Import Penetration Ratio for Products of Manufacturing Industry', no. 121 (1985).

Table 1.3 Ratio of UK Imports to Home Demand for all Manufacturing and for Selected Sectors (1973 - 1983)

Against this background of decline it is interesting to note that successive UK Governments have tended to act on the sometimes painful premise that exposure to overseas competition is a necessary ingredient for the development of a strong, domestic manufacturing base.

What is of deep concern, however, is that manufacturing industry's response has been woefully slow. Many firms have tended to keep their corporate eye on domestic rather than overseas competitors. The result is that they have adopted inadequate, reactive strategies because the consequences for manufacturing have not been appreciated.

Typically, they have filled capacity by chasing orders, increasing variety and reducing batch sizes, leaving overseas competitors with substantial advantages in the higher-volume segments of their markets. Many businesses had failed to recognise until too late in the day, that the sellers' markets of the 1950s and 1960s had long since passed and that the 1980s required new strategies aimed at gaining and maintaining some specific and significant advantage against the most, not least, powerful of their competitors.

Whereas the UK in particular was being buffeted by this new competitive surge, that was not so for some nations which moved from strength to strength. The exhibits given earlier in this chapter have illustrated how Japan, West Germany and others are showing up well in the international league tables. Of deeper concern for the UK, however, were the facts underlying these trends, especially that of competitive productivity.

1.22 PRODUCTIVITY : NATIONAL COMPARISONS

The prosperity of a nation is generally recognised as being significatly influenced by its comparative productivity. In two decades of increasing competition, this has been brought sharply into focus. Although productivity does not provide a precise measure of performance (nor is it a simple measure, due to the global nature of the figures involved), it does offer an overview that is useful in assessing the trends in a country's own performance and in its relative position in world rankings.

There are two important dimensions of a productivity slowdown for any nation. The first is the rate of the slowdown itself and the second is the cumulative effect of the slowdown on the comparative level of productivity between a country and its competitors.

Productivity measures the relationship between outputs (in the form of goods and services provided) and inputs (in the form of capital, material, labour, energy and other resources). Although it is difficult to get a consensus on the quantitative dimensions of productivity measurement (Appendix 2 offers a short discussion), the qualitative conclusions on the size and duration of the problem for the UK are clearly shown.

Table 1.4 provides an overall review of performance in terms of gross domestic product per employee between 1973-85. Except for the US and Canada, the UK has consistently achieved lower growth rates than other leading industrial nations even taking into account the improved performance in the last 5 years of this period.

	Gross Domestic Product per Employee					
	Relative Level				*Annual Growth*	
Nation	*1960*	*1977*	*1985*	*1986*	*1973–85*	*1981–85*
United States	100	100	100.0	100.0	0.4	1.0
Canada	86	92	99.8	101.9	1.1	1.6
France	57	85	93.6	93.2	2.1	1.7
Japan	25	63	75.5	75.2	2.9	2.9
Korea	NA	NA	NA	33.9	4.9	6.0
United Kingdom	53	56	76.1	76.5	1.6	2.6
West Germany	53	79	93.4	93.0	2.2	2.1

Notes: 1. American Productivity Center "Productivity Perspectives" 1987 Edition with supporting information supplied by the Center for 1973.
2. NA means not available.

Table 1.4 Trends in Gross Domestic Product per Employee 1973-85

The UK's failure to maintain similar improvements in productivity over time is further illustrated by Table 1.5 which traces the output per hour in the manufacturing sector for the UK and other leading industrial nations since 1950. While the UK and US have remained static between 1950 and 1984 other industrial countries have forged further ahead or overtaken the UK during this period. The productivity slowdown and the picture that emerges when comparisons are made with other leading industrial nations point to justifiable concern.

	Manufacturing Sector							
	Output per Hour				*Average Annual % Change in Output/Hour*			
Nation	*1950*	*1973*	*1981*	*1984*	*1950–60*	*1960–73*	*1973–81*	*1981–84*
United States	100.0	100.0	100.0	100.0	2.0	3.2	1.3	4.6
Canada	51.8	77.0	77.8	74.6	3.8	4.7	1.6	2.3
France	NA	NA	NA	NA	4.9	6.5	4.4	5.3
Japan	11.3	56.1	82.1	92.1	9.5	10.3	5.5	6.2
United Kingdom	40.8	47.5	40.0	42.0	2.0	4.3	1.6	5.5
West Germany	33.4	78.0	80.6	81.4	7.4	5.8	3.5	4.1

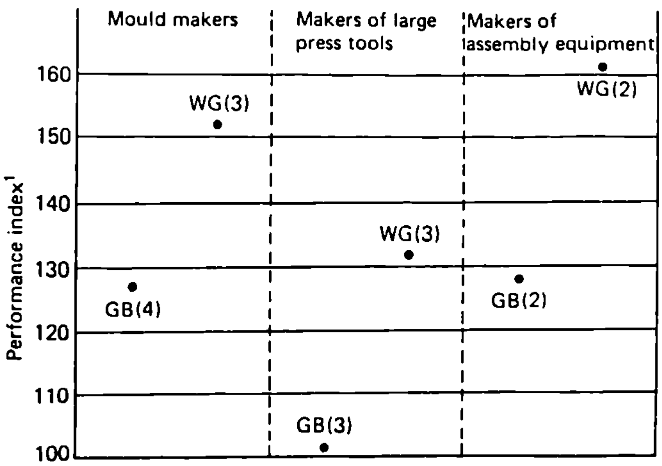
Notes: 1. Data on real output per hour is based on constant 1975 U.S. dollars.
2. Actual output per hour is shown for the other 5 countries relative to the U.S. 1950, 1973, and 1984 figures.
3. NA means not available.

Source: International Productivity Comparisons—Economics, Sectors, Manufacturing Industry Group by G. E. Sadler, American Productivity Center, 1986.

Table 1.5 Output and Average Percentage Change in Output Pattern in the Manufacturing Sector from 1950 to 1984

1.23 PRODUCTIVITY : PLANT LEVEL COMPARISONS

The argument that national level productivity levels can be misleading is not unreasonable. Such an analysis will include industries at different stages in different life cycles which may distort results. To obviate this possible distortion there is a case for making assessment at the plant or industry level. A report on the toolmaking sector assessed the relative performance of 17 UK and West German companies in the product sectors of mould, large press and assembly equipment manufacturers. A performance ratio based upon added value divided by total employment costs and adjusted for employee cost differences was used to compare companies within three sectors. The average performance of UK companies and their West German counterparts is provided in Figure 1.3 and shows a consistent underperformance by the former of between 20 to 30 percent.



	Number of companies concerned		
UK	4	3	.2
West Germany	3	3	2

[1]Base of 100 for the lowest performing company in the total sample

Note: In each column the figure shown is the average for the companies in that sector in the country concerned, and the number in brackets is the firms involved.

Source: Gauge and Tool Sector Working Party's Report (1981), p.vii, Figure 1.

Figure 1.3 Relative performance of UK and West Germany companies by sector (National Economic Development Office, 1981)

These differences were again illustrated by a 1983-4 Anglo German survey (Daly et al 1985) of twenty-five UK and twenty West German firms in the metal-working trades, From within the larger survey, six pairs of firms, selected on the basis of matched and simple, products were analysed. In all six comparisons, the West German firms showed higher labour productivity varying from 10 to 130 percent with an average of 63 per cent.

The third illustration is taken from a Ford Motor Company series of presentations to suppliers in the early 1980s. The purpose of these were to highlight the size of the productivity gap beween European and Japanese car plants. The figures in Table 1.6 speak for themselves and illustrate not only the significant difference between Japan and Europe but also beween the UK and other European plants.

Aspect	Ford Transit		Toyota Hiace
	UK	Belgium	
Number per shift at similar build rate			
Directs	1024	643	350
Inspectors	83	68	15
Other indirects	929	287	45
Total	2036	998	410
Total manpower per unit build	12.5	7.2[1]	2.4

[1] This particular figure related to West Germany, not to Belgium.

Table 1.6 Assembly Plant Productivity Comparisons, Toyota and Ford

The results were illustrated in Table 1.3 and more recent figures show the continuation of this trend - the outcome of being outperformed by our competitors (see Table 1.1 and Figure 1.2 given earlier).

1.24 WHY HAS THIS HAPPENED?

The reasons why this has happened are many and varied. Some are unsubstantiated opinions, others supported by fact. Some will be more relevant to some industrial sectors and companies and others, less. However, learning from past failure is a step toward determining how to build a more successful, competitive future.

1.241 Failure to recognise the size of the competitive challenge

There has been a failure, conscious or otherwise, of industry and society at large to recognise the size of the competitive challenge, the impact it was having and would have on our very way of life, and to recognise the need to change.

One illustration of UK industry's lack of awareness is provided in a selection from the corporate reponses to the 1976 Select Committee of Science and Technology (Japan Subcommittee) seeking evidence on several aspects of Japanese industry. The subcommittee wrote in September 1977 to many leading British manufacturing companies and related associations seeking their views on a number of perspectives within Japanese industry. There follows a précis of some of the points raised in the replies received, with the name of the organisation, and particlar aspect(s) to be addressed.

Ford Motor Company's comments on the success with which Japanese industry has handled its process and product development (Select Committee on Science and Technology, 1977/78)

> I am not sure that we have anything useful to contribute on this issue so far as the motor industry is concerned because all the processes and products used by the Japanese motor industry are known to us and their success depends on achieving economies of scale based on a large home market, on a different attitude adopted by labour in their industry and also on their apparent success in containing inflation more effectively that we have been able to do in this country.
>
> In short, as far as the motor industry is concerned the general superiority of the Japanese seems to me to be in the area of attitudes and economies rather than technology.

Ford's comments also mention that the Japanese "are very competitive in their strategic thinking and their marketing plans, but ... there is nothing they do in these areas either that is not known and practised by some of us at least in the motor industry in the West".

Yet, less than three years later, the Ford Motor Company was holding seminars within all its major suppliers to detail the critical nature of the Japanese challenge and examining the stark comparisons of performance, amongst others, which were provided earlier in the chapter. Based on the improving percentage of the Japanese free world vehicle production (10 to 26 per cent from 1966 to 1979) and the decline in the European percentage (38 to 34 per cent) in the same period, Ford concentrated much of its discussion on the manufacturing perspective as the foundation for this challenge. As the Ford Report admitted, the extent and nature of the superiority was not appreciated until Ford went to see for themselves.

But Ford were not the only company which failed to appreciate the extent of the challenge.

Rank Organisation commented on the introduction of new products and improved production methods used by Japanese industry, as follows:

Whilst subscribing "on the whole to the generalisation that Japanese industry has performed in the ways described, better than the UK", Rank considered that Japan "would seem to have the following advantages compared with the UK, at least in the products/markets where they are conspicuously successful".

The reply then lists seven advantages which were, in summary form:

(1) High prestige of industrial activity and careers in management and technology.
(2) Ample supply of potential managers, engineers and technologists.
(3) Full support by operatives and trade unions to productivity increases and high quality attainment.
(4) Better personal motivation through taxes, rewards and strong work ethic.
(5) Unique relationship between government, banking and industry.

(6) Home market highly protected.

(7) Buoyant economy helps exploit new technologies and inventions.

Rank's reply then detailed three steps to be taken to help redress the stituation. These related to points (1), (2), (4) and (6) above. Thus, like Ford, Rank in late 1977 was stressing not the key manufacturing and business issues (that is, aspects over which the company had substantial and significant control and direction) but aspects which were governmental or cultural in origin (that is, aspects over which they had little control and direction).

Yet in the early 1980s, the Rank/Toshiba television plant in Plymouth illustrated how the initial failure of the joint venture was turned into a successful manufacturing unit when Toshiba took full control. And, this is not the only example of initial failure being turned into success when Japanese management took over. Similar cases are provided from elsewhere including Motorola's TV assembly plan in Illinois taken over in the early 1970s by Matsushita, the Sony TV plant at San Diego, and the Sanyo Electric plants in Arkansas and California.

Further, apparent misunderstandings or lack of awareness of the nature and extent of competition were displayed in the content, tone and extent of other replies, for example, the Motor Industry Research Association.

These views, however, were not shared by all contributors. Many were aware of the differences in corporate attitude and priorities, thus providing a sharp contrast to the earlier examples:
Electrical Research Association replied:

> "Japanese industry is successful in those products it has chosen for world-wide marketing because there is a total commitment to manufacturing high quality, reliable goods on a very large scale, as much effort being committed to the production process and technology as the products themselves. In the United Kingdom we have very large resources and our best talent locked up in irrelevant basic research. Manufacturing industry attempts to survive with the minimum resources and too little skill and investment in the production and quality control process".

EMI's response was similarly biased towards a recognition of the Japanese manufacturer's approach to markets and production. For instance,

- Japanese manufacturers study competitors' products, technologies and market needs in much greater depth than their European counterparts.

- Advanced developments are embodied in the products and in the manufacturing processes. This gives the commercial products a technological lead and a cost advantage - two significant factors in establishing a significant market position..

Some companies even recognised the gravity of the problem and the speed of response which must be made. For instance, in the mid 1970s BOC Ltd identified "certain technical aspects of small batch manufacturing in which considerable practical experience has been obtained in Japan and for which no equivalent knowedge exists in the UK". Linked machining centres which had been in operation for five years in Japan were not known to exist in the UK or even being contemplated by any British machine tool manufacturer. In summary, BOC's reply concludes that "the action we in Britain take in the next two years can be critical in ensuring a continuing viable manufacturing industry in this field, and especially the machine tool aspect".

1.242 Failure to appreciate the impact of increasing manufacturing capacity

World manufacturing capacity up to the mid 1960s was, by and large, less than demand and in this period firms could sell all they could make and none moreso than the UK with its traditional Commonwealth markets. The redressing of this capacity/demand imbalance heralded the growing prominence of the marketing function: the recession of the late 1970s and earlier 1980s saw the accounting/finance function further increase its influence. During this time, the manufaturing perspective within the corporate strategy resolution diminished. The result has been that many companes have become almost entirely marketing-orientated. New product introduction and product differentiation have, therefore, become the predominant corporate approach to strategy development. Opportunities are explored leaving the aftermath for manufacturing to resolve. Couple this with the increasing pre-eminence of financial measures and the results has been a corporate policy in many UK companies where investment for product innovation and associated manufacturing requirements has been relatively plentiful, whilst that for process innovation has been relatively scarce. This is not so in Japan. A survey in the early 1980s (Boston University, 1983) revealed that, whereas process engineering functions in North American and European companies were, respectively 6 and 5 per cent likely to get their project proposals approved, in Japan it was 27 per cent. The consequences of this have been several:

(1) For many companies, it has resulted in a widening inability to meet changing patterns of demand. Clasically, whilst manufacturing technology and the perceived manufacturing task were moving towards even more mass production and the economies associated with that direction, markets were responding to greater competitive

pressures which, in turn, led to wider product ranges and resultant lower volumes.

(2) Strategic investment in manufacturing has, overall, been discouraged with the result that the process technology advantage enjoyed by our competitors continues to increase:

- Corporate performance is measured predominantly in terms of return on investment. In addition, the need to demonstrate (sometimes twice yearly) the expected progress to the business, its shareholders and the stock market puts unwise and unnecessary pressure on short-term performance. This, in turn, adds weight to the argument to keep investment low as a way of keeping returns relatively high.

- Top management's inexperience in manufaturing provides an unreceptive climate in which to consider strategic process investment. Risk aversion, so much a part of the corporate financial argument, also favours holding-off.

(3) The diminishing role of production in strategy has led to a corresponding lack of involvement in the corporate debate. One consequence has been that the engineering dimensions has been the predominant basis on which process choices have been made. This has led to situations where processes have been installed which, though excellent in themselves, were not appropriate to the business needs. Tripping over white elephants from the past, has made managements wary of the future.

1.243 Top Management's lack of manufacturing experience

Top management's lack of experience in manufacturing has further ramifications for a business. Considering the fact that manufacturing accounts for some 70-80 per cent of assets, expenditure and people, then it is imperative that senior executives fully appreciate the arguments and counter-arguments in manufacturing so as to ensure that the accompanying wide range of perspectives are taken into account when making important manufacturing decisions. Once large investments have been made then rarely does a company invest a second time to correct the mistake. This lack of experience is certainly not so in Japan and West Germany where a full and perceptive insight into manufacturing is seen as a prerequsite for top management.

A survey (Wall Street Journal (Europe) and Booz-Allen Hamilton, 1984) on 'The Management of Technology' based on over 200 chief executives in 16 European countries, listed amongst its "significant findings" that there was a "surprising emphasis by European executives on cost reduction as a primary objective of technology". The European Panel members "rank cost reduction in the factory as by far their most important objectives for technology". That attitude clashes significantly with the findings of comparable studies among US and Japanese executives. Those business leaders display a far more aggressive attitude, ranking innovation in the form of new products, improved product performance or improved customer service higher. It goes on to quote one view, which was supported by a number of Europe's leading executives, that there is "a desire to extend the life of the smoke stack industry. Many view technology as a way to extend the current product line past the point where it could go otherwise".

1.244 The Production Manager's obsession with short-term performance issues

The emphasis within the production manager's role has, in turn, been directed towards short-term issues and tasks. The overriding pressures to meet day-to-day targets and the highly quantifiable nature of the role have reinforced the tendency of manufacturing executives to concern themselves with this feature to the exclusion of the important long-term. The skills of production managers are high on short-term tasks such as scheduling, maintaining efficiency levels, controls, delivery, quality and resolving labour problems.

Skinner (1982) rightly believes that

> "most factories were not managed very differently in the 1970s than in the 1940s and 1950s. Manufacturing management was dominated by engineering and a technical point of view. This may have been adequate when production management issues centred largely on efficiency and productivity and the answers came from industrial engineering and process engineering. But, the problems of operations managers in the 70s had moved far beyond mere physical efficiency."

However, this predominance of the short-term is reinforced by the view which companies have of the production management role. An analysis of job advertisements in the period 1970-9 (Hill et al, 1981) revealed that of all the aspects mentioned concerning job content, 50 per cent for managers and 52 per cent for directors concerned the need for day-to-day management and a knowledge of support functions. Similarly, the appropriate work experience mix which a suitable applicant would need revealed that for managers, 54 per cent of all mentions referred to their experience record as production managers and use of management controls and techniques. For directors it accounted for 51 per cent of all mentions. In contrast, the same ten-year analysis revealed a correspondingly low emphasis on, or requirement for, the long-term, corporate contribution. The job content mentions were 8 per cent and 13 per cent for managers and directors with typical work experience of applicants at 3 per cent and 4 per cent respectively.

But, the production job has changed from one which concerns maintaining steady state manufacturing by sound day-to-day husbandry to one which is multidimensional. It is now increasingly concerned with managing greater complexity in product range, product mix, volume changes, process flexibility, inventory, cost and financial controls and employee awareness due to the more intensive level of domestic and international competition.

This is the nature of the new task. No longer are the key issues solely confined to operational control and fine-tuning the system. The need is for broad, business-orientated manufacturing managers but companies have too few of them. The use of specialists as the way to control our businesses has increasingly led to a reduction in the breadth of a line manager's responsibilities which has narrowed the experience base. Furthermore, many manufacturing managers have been outgunned by specialist argument and found themselves unable to cope with the variety of demands placed upon them. The response by many has been to revert increasingly to their strengths. This has, therefore, reinforced their short-term and their inherently reactive stance to corporate strategic resolution.

Manufacturing executives do not, on the whole, explain the important, conceptual aspects of manufacturing to others in the organisation. Seldom do they evaluate and expose the implications for manufacturing of corporate decisions, so that alternatives can be considered and more soundly based, corporate decisions agreed. Part of the reason for this is that there is a lack of developed language to help provide a way of explaining the corporate production issues involved. Lacking, therefore, in strategic dimension, manufacturing has often been forced into piecemeal change achieving what it can as and when it has been able. The result has been a series of intermittent responses lacking corporate coordination.

1.3 REASONS FOR UNDERTAKING THE RESEARCH

In many companies there is an ineffective handling of cross-functional issues at the strategic level. The use of functionalisation and specialists as part of the basic control mechanisms within organisational structures reinforces the lack of business coordination which typifies business reality and increases the tendency to base corporate decisions on single functional dimensions. Within this environment, production managers tend to take a reactive role in formulating corporate strategy. Yet, how can the perspectives of that function which controls such a large part of the assets, costs and people be omitted?

The fact that manufacturing executives have an exacting and critical role to play is undisputed. Why then, do they adopt their current role, and why does this situation exist and not appear to improve? There are several reasons, the more important of which are detailed below:

- **Production Managers' view of themselves** : one of the major contributions to this situation appears to be that Production Managers also see themselves holding a reactive corporate brief. They too define their role as being one which requires them to react as well as possible to all that is asked of the production system. They see their role as:

a) the exercise of skill and experience in effectively coping with the exacting and varying demands placed on manufacturing
b) to reconcile the trade-offs inherent in these demands as best they can.

Thus, rarely do they adequately contribute to the making of corporate decisions, which result in a demand on manufacturing. They do not explain the different sets of manufacturing implications created by alternative policy decisions and changes in direction. They fail, by default, to contribute as the corporate level, and hence to help the company arrive at decisions which embrace all the important business perspectives.

- **The Company's view of the Production Manager's Role** : Production management's perceived role of reacting to the demands placed upon it and a prime concern for the short-term that this implies is reinforced by the corporate view of this function's contribution, and hence the qualities incumbents should possess. Many companies typically promote operators to foremen, foremen to managers, managers to executives with scant regard for the change in emphasis that needs to take place and with little help to make this transition a success. One major company, recognising the important corporate contribution to be made by its manufacturing executives, undertook a series of tailor-made courses in manufacturing strategy. The first of these comprised 16 factory managers who, during the course, reflected that as a group their aggregate company service exceeded 300 years, yet the collective training they had received to help them prepare for their manufacturing executive role was less than 30 days.

On a broader front, the survey of UK recruitment referred to earlier (Hill et al, 1980) further confirmed this view. In terms of the appropriate work experience of suitable applicants, or the content of the job being advertised, the number of mentions concerning the day-to-day management tasks was relatively high, compared with the low number of mentions concerning the corporate or long-term contribution given earlier (see Table 1.7).

	Mentions as a Percentage of the Total in U.K. Advertisements 1970–79	
Job Category	*Corporate Policy Long-Term/ Corporate Contribution*	*Day-to-Day Management/ Record of Production Management*
Production managers		
Work experience	3	34
Job content	8	23
Production directors		
Work experience	4	32
Job content	13	27

Table 1.7 Perception of Long-Term Versus Day-to-Day Aspects of Production Executives Jobs and Applicants' Qualifications

- **Top Management's view of strategy** : the authors of business plans and corporate marketing reviews look outward from the business. Top executives associate themselves with these activities, seeing them as legitimate, corporate strategy issues. They concentrate their attention of the external environment in which the business operates.

Manufacturing plans are built in line with the stated business needs and are based upon the internal dimensions of the processes involved, and top executives are less likely to associate themselves with these activities. Typically, they request a manufacturing strategy statement from the production executive without being involved in its structure and development. They assume that it is not an inherent part of their role which increases the difficulties in establishing a corporate strategy through dialogue and understanding. This tendency highlights the failure of top executives to recognise the external dimension of manufacturing. The function's internal perspective tends to dominate the broad view of the contribution that it can and needs to be making.

However, the key task in corporate strategy is matching the external requirement (the market) and the internal capability (of which manufacturing typically provides a significant part). One consequence is that the resolution of these issues has been abdicated by top managment, or at best has occurred outside the boundaries of their business awareness.

- **Production Managers are too late in the corporate debate** : Production managers are often not involved in corporate policy decisions, until these decisions have started to take shape. The result is that production executives have less opportunity to contribute to decisions on strategy alternatives and as a consequence always appear to be complaining about the unrealistic demands made of them and the problems that invariably ensue.

- **A Lack of language and concepts** : on the whole, production managers do not have a history of explaining their function clearly and effectively to others in the organisation. This is particularly the case in terms of the manufacturing strategy issues that need to be considered and the production consequences that will arise from the corporate decisions under discussion. On the other hand, marketing and financial executives have explained their functions comparatively well. They can talk about policy alternatives in a straightforward and intelligible manner.

The reasons for this difference cannot, however, be wholly placed at the production manager's door. The knowledge base, concepts, and language have not been developed in the same way. Consequently, shared perspectives within manufacturing are few - a point well illustrated in the next chapter where the sparsity of contribution becomes apparent.

1.4 PURPOSE OF THE RESEARCH

The purpose of this research is, therefore, directed towards helping to improve the conceptual base of manufacturing strategy. It is directed towards translating some of the intuitive perspectives which typify the approach adopted by production managers at both the operational and strategic levels of their role into relevant and useable concepts and methodologies. Until the manufacturing function is able to explain the implications for production (and hence the business) of strategic alternatives then other executives will be unable to partake in this essential debate and agree relevant strategic outcomes which are best for the business as a whole.

Manufacturing strategy concerns reflecting in the investments within the production function the different market pressures of a business. A methodology to bring about this strategic development would need to recognise that -

a) the 'market-related' inputs to manufacturing strategy formulation are more relevant to this process when expressed in manufacturing, rather than conventional marketing terms

b) invesments in manufacturing will embody different sets of trade-offs between major process and infrastructure characteristics (for example, process flexibility, inventory levels, manufacturing planning and control systems and capacity increases)

c) strategy formulation is more effective when the process recognises that whereas markets are inherently dynamic, manufacturing investments are inherently fixed. Thus, relevant process and infrastructure investments today may not adequately support the markets of tomorrow

The above are 'research questions' rather than hypotheses in the strict 'testable' sense. Their purpose is to focus the broad basis of the research around some central issues in the manufacturing strategy formulation process. The research has then been directed at testing whether the above issues are meaningful in themselves and pertinent to businesses in terms of providing relevant manufacturing perspectives which would need to form part of the corporate strategy debate.

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Page(s)	Appendix	Company	Date
109	1	Ford Motor Company	Oct 77
111-112	3	Rank Organisation	Oct 77
179	31	Motor Industry Research Association	Oct 77
180	32	Electrical Research Association	Nov 77
131	17	EMI Group	Nov 77
110	2	BOC	Sep 77

Skinner, W (1982) "Operations Technology : Blind Spot in Strategic Management" Working Paper : Harvard Graduate School of Business Administration, October p6

Wall Street Journal (Europe) and Booz-Allen Hamilton Inc (1984) European Panel of Executives, No 1 "The Management of Technology", February p3.

2 LITERATURE REVIEW

As explained in the last chapter, the review of relevant literature in the field of manufacturing strategy covers the period upto and including the start of my research which began in the early 1980s. In this way it gives an overview of the position which prevailed at the time and thus provides an understanding of the context against which the research reported in later chapters can be placed. However, its principal role is to identify areas where further work needed to be completed and to signal priorities in terms of those aspects of manufacturing strategy which needed to be developed.

Before detailing specific contributions to the development of this field, a look back at the major phases in corporate strategy development with particular regard to manufacturing inputs would give general insights into why many UK companies had got themselves into a position of formulating corporate decisions without embracing the necessary inputs from its major functions.

Phase 1 : the period from the end of the second World War until the early 1960s was one characterised by a general world under-capacity in most areas of manufacturing. The consequence was that manufacturing held a "dominant" role within many companies. As most products made could be sold, the key to overall corporate success was in the hands of manufacturing.

Phase 2 : the early to mid 60s saw a significant change. The world demand/ supply imbalance of the previous period was increasingly being corrected. The result was the growing emergence of marketing as a strategic force as this function's role in overall corporate success was being recognised.

Phase 3 : the 1973 oil crisis and particularly the recession of the late 1970s and early 1980s brought the importance of the financial function sharply into view. Its growing role in corporate argument was increasingly (and still is) being felt.

Although the phases described above are general in nature and the timings may well be questioned, they do illustrate an important trend in strategy development. From 1945 onwards, the corporate strategy decisions in many firms has been unduly influenced by the dominance of different functions at different times. By the early 1980s (the time when my research began) manufacturing had tended increasingly to adopt a reactive role as described in the last chapter. But, the logic of any company which fails to embrace the inputs from all its major functions is highly questionable, particularly with the characteristics of world markets leaning towards becoming increasingly more dynamic and competitive.

Within this scenario there had been a small clutch of contributors working in the field of manufacturing strategy. They clearly recognised the inadequacy of formulating major decisions without the inputs from the production function where investments in both process and infrastructure were the most significant and that, given the UK trends illustrated in Chapter 1, this position could not be sustained. However, as the literature review will illustrate the main contributors, those who offered concepts to help move the area forward, were few in number.

The literature review which follows is primarily chronological in order to help trace developments and also to distinguish between the level and nature of contributions over time. References are provided throughout and the chapter is supplemented by the additional material given in Appendix A.

The three phases of functional dominance suggested earlier are my own. They are based partly on my own views and in part it reflect developments in the literature. An example of the latter is provided by the initial reference which has been chosen for this and other reasons. Wickham Skinner is recognised by many as the person who has made the largest, contribution to this field. Although wistfully describing himself at a recent conference as "Johnny One Note" you will, I hope, agree by the end of this section that he provided a symphony of ideas from statement definitions to major insights pointing the way forward.

As early as the mid 1960s, Skinner (1966) had a clear insight into the magnitude of the problem facing the US and other countries with long manufacturing traditions, the source of those problems and how manufacturing needed to, and how it would be able to, contribute to improving overall corporate performance. In fact, a brief review of the major points within his 1966 article offers adequate context for the initial phase of manufacturing strategy. He identified for the US

1) New pressures from outside the firm in the form of increasing competition and marketing pressures of cost, quality and delivery lead times
2) Problems from within - plants geared up for characteristics of yesterday's markets including:-
    a) long runs
    b) stabilised engineering designs
    c) style of production management
    d) intensive use of labour standards and incentives

Appendix A.1 provides a complete list.

This, he explained, had resulted in a second "set of problems which are complicting life in the factory". He reflected that "by and large these are actually old problems made critical by the outside pressure and the accelerating rate of technology. It is their urgency which makes them new"

(1966, p141). He then identified the following issues -

1 "Re-evaluating cost control" due to the changes in cost structure and the failure of companies to modify existing concepts, systems and procedures
2 Changes in the mix and base of skills required
3 Increased paperwork resulting from "increasingly complex information systems"
4 Accelerating technology developments which highlighted the need to consider equipment decisions in terms of skills and investment costs, engineering's response to product change, the need for shorter lead times and the opportunities and problems brought about by a flood of new developments in materials and processes.
5 He highlighted the changing nature of relevant markets and the failure to respond in manufacturing. He pointed out some of the then more recent developments in manufacturing including statistical process control and experience-curve phenomenon while emphasising the need for manufacturing managers to think differently.
6 Finally, he argued the view that there was a growing corporate need to recognise the increasing role of production in strategy development due to more rapidly changing market requirements. This resulted in a failure by companies to recognise production as a competitive weapon in terms of improving overall business performance (1966, pp140 and 145).

So, the scene was set! The principal elements were signalled - the weight of competition, the recognition of the new order and of the need to re-orientate manufacturing's role in terms of its corporate contribution. But, these early signals were only broad statements of the need for change and the nature of manufacturing's revised role. Understandably it is often necessary to first point oneself in a more appropriate direction - a stage which normally precedes action. But, exaltation is not, in itself, enough.

However, it was an important start. And, others too were becoming aware of the growing problems for manufacturing and alerted to the need to re-think current approaches which were, at least in part, contributing to the overall decline of several large industrial nations with sound, well-established manufacturing pedigrees.

The style and contribution from other academics and practitioners outside the immediate area of manufacturing was understandably less forthright in highlighting the production function's role change. Some, for example, included manufacturing's contribution by implication or as part of a general, all-embracing statement of the need for a business to look afresh at market opportunities and traditional approaches (Levitt, 1965). While others identified the specific need within companies for "downstream coupling" between R & D, manufacturing and marketing (Ansoff and Stewart, 1967).

However, in these formative years the more precise statements of need and the early developments within manufacturing strategy came principally from the Harvard Business School stable and particularly from Wickham Skinner. His bellweather article in 1969 represented a bold statement of the importance and nature of the manufacturing contribution to the corporate strategy debate. This statement began by reinforcing the failure of companies to embrace the production dimension within corporate strategy formulation and clearly ephasised manufacturing's critical contribution which emanates from its organisational size. The outcome, he emphasised, was one of the strategic alternatives "competitive weapon or corporate millstone".

The rest of his article, however, introduces some key facets within the field -

a) the need for integrative mechanisms
b) cause and effect factors which determine linkage between strategy and production (p139)

c) the concept of trade-offs within manufacturing investments

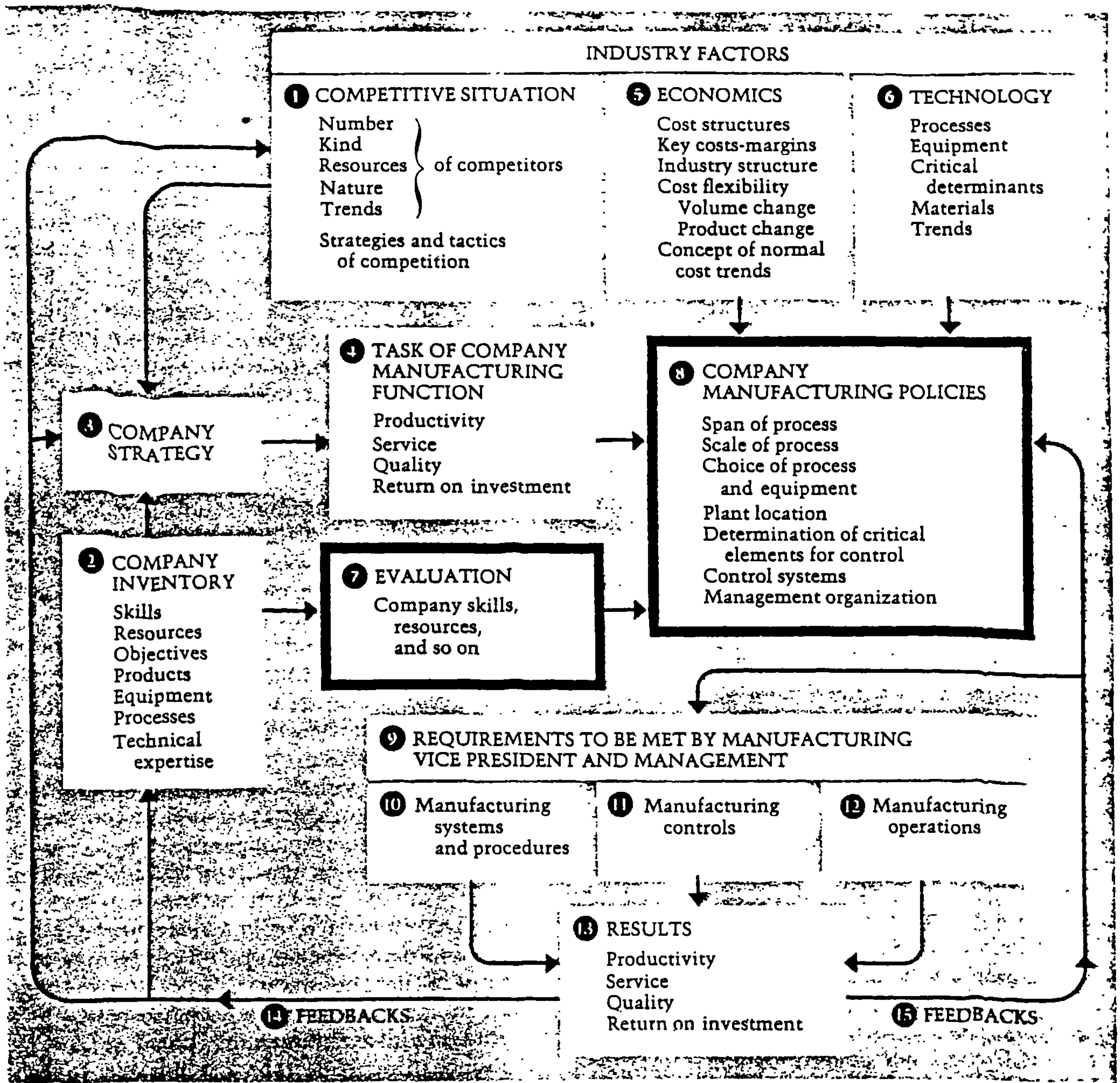
d) a "process of manufacturing policy determination" as shown in Figure 2.1

What Skinner (1969) clearly recognised was that "manufacturing policy must come from corporate strategy and that the process of determining this policy is the means by which the management can actually manage production" (p144).

This Skinner article at the end of the 1960s heralded a new decade, one however, where the performance of some major manufacturing nations continued to decline. The literature contributions throughout the next ten years were understandably mixed and fall within a number of different themes. It is within these that the major contributions in this period are now reviewed.

2.1 STATEMENTS OF THE PROBLEM

Although most contributions in any field include statements of the perceived problem or need, there are some whose principal theme concerns this perspective. In UK terms, however, the development of PROMAG (Production Management Action Group) by leading academics signalled a most positive statement of need which was ably compiled by Gallagher and Wild (1976) from contributions by six leading POM academics of the time. It provided a clear statement of the problem highlighting the reactive as opposed to proactive nature of production management in terms of corporate contributions. Elsewhere in the UK the few statements on these issues confined themselves to statements of the problem, for example Lockyer (1976) and Gill (1979). In the US there were similar examples comprising statements of the problem (Hanan, 1974; Hobbs and Heaney, 1977) but more



Key

1. What the others are doing
2. What we have got or can get to compete with
3. How we can compete
4. What we must accomplish in manufacturing in order to compete
5. Economic constraints and opportunities common to the industry
6. Constraints and opportunities common to the technology
7. Our resources evaluated
8. How we should set ourselves up to match resources, economics, and technology to meet the tasks required by our competitive strategy
9. The implementation requirements of our manufacturing policies
10. Basic systems in manufacturing (e.g., production planning, use of inventories, use of standards, and wage systems)
11. Controls of cost, quality, flows, inventory, and time
12. Selection of operations or ingredients critical to success (e.g., labor skills, equipment utilization, and yields)
13. How we are performing
14. Changes in what we have got, effects on competitive situation, and review of strategy
15. Analysis and review of manufacturing operations and policies

Figure 2.1 Skinner's Process of Manufacturing Policy Determination (1969, Exhibit II, p143) significantly there was a growing volume of work which was breaking new ground.

2.2 DEVELOPING EXISTING IDEAS

The principal source of developments of existing ideas was without doubt Harvard Business School.

Incorporating and building on earlier work with Utterback (1975) and Townsend (1975), Abernathy's research (1976) led to propositions concerning production process selection, inherent trade-offs associated with these choices, and links to product life cycles. In this he provided more detailed insights into the stated need to reconcile "production policies and other functional polices" by proposing the hypothesised relationships among aspects of a plant as shown in Figure 2.2.

However, it is about this time that the issue of trade-offs began to be highlighted and developed on a more widespread basis as exemplified by its position in Harvard Business School's Production/Operations courses and related papers as illustrated below -

- 1975 Process Analysis: Harvard Business School Paper
- 1978 POM courses - well-established, indicating movement away from the traditional, quantitative base for teaching POM (sometimes referred to as the Buffa-era) to the management of the area
- 1978 Manufacturing Strategy course - this provided a capstone programme for the Harvard Business School production/operations management areas supported by a series of case books by Skinner and Rogers (1968) which were devoted to a particular sector of manufacturing eg furniture, oil and chemicals.

	INNOVATION	PRODUCT LINE	PRODUCTION PROCESS	ORGANISATIONAL CONTROL	KIND OF CAPACITY
FLUID BOUNDARY					
Normal Direction of Transition ↓	Frequent & novel product innovation-market stimulated.	High product line diversity produced to customer order.	Flexible, but inefficent. Uses general purpose equipment & skilled labour	Loosely organised. Entrepreneurially based	Small scale, located near technology source or user Low level of vertical integration.
	Cumulative product innovations usually incorporated in periodic changes to model line and	At least one model sold as produced in substantial volumes. Dominant design achieved.	Increasingly rationalised process configuration with line, flow orientation, relying on short duration tasks and operative skills of the work force.	Control achieved through creation of vertical information systems, lateral relations, liaison and project groups.	Centralised general purpose capacity where scale increases are achieved by breaking bottlenecks.
	Increase in process innovation - internally generated and	Highly standardised product with few major options.	"Islands" of specialised and automated equipment introduced in some parts of process	Control achieved by means of goal setting, hierarchy and rules as the frequency of change decreases	Facilities located to achieve low factor input costs, to minimise disruption and facilitate distribution.
	Technology stimulated innovation.	Commodity-like product specified by technical parmaters.	Integrated production process designed as a "system".	Bureaucratic, vertically integrated, and hierarchically organised with functional emphasis.	Large scale facilities specialised to particular technologies. capacity increases achieved only by designing new facilities.
	Cost stimulated incremental innovation predominates. Novel changes involve simultaneous product and process adaptations and are infrequently introduced.		Labour tasks predominantly ones of systems monitoring.		
SPECIFIC BOUNDARY					

Figure 2.2 Summary of hypothesised relationships among aspects of a plant (Abernathy and Utterback, 1975)

In addition to these extensions to some of the early ideas, there were also two important developments to the core issue of manufacturing strategy itself in terms of its role and composition.

The first was the work of Hayes and Schmenner (1978). The key feature of their statement was the enlargement of the principal features of manufacturing strategy proposed earlier by Skinner, the most important of which were -

i) heavy emphasis on the need to recognise corporate strategy differences as part of the rationale on which to base manufacturing investments. It also signified and discussed some of the key alternatives as part of this emphasis, including the dominant company orientation, the pattern of corporate diversification and the firm's attitude towards growth

ii) highlighting, with details, the competitive priorities which, by implication, reflect manufacturing tasks. These are specified as embracing

- dependability
- quality
- price
- volume flexibility
- product flexibility

iii) establishes clear links between (ii) above and manufacturing strategy. They saw the manufacturing mission as "once its attitudes and competitive priorities are identified then the task of manufacturing is to arrange its structure and management so to mesh with and reinforce the strategy" (Hayes and Schmenner, 1978, p108)

iv) They listed the detailed components of manufacturing as involving

- processes
  - capacity
  - size and location of plants
  - kind of equipment and production technology
  - span of process
- infrastructure
  - inventory control
  - manufacturing planning and control system
  - process design
  - workforce
  - quality control
  - manufacturing organisational design

v) They emphasised the problems associated with delegating key manufacturing decisions to "manufacturing specialists". They argued that the more this happened the more likely it was that manufacturing's priorities would be different from corporate priorities in that "they will reflect engineering priorities (and) not the needs of the business" (Hayes and Schmenner, 1978, p108)

vi) Finally, they provided insight into product and process focus which reflected and added to the focus work of Skinner (1974) a development which is discussed in the following section

The second important contribution was by Wheelwright (1978). This in many ways paralleled the earlier work of Hayes and Schmenner (1978) which is understandable given the fact that they were all at that time from the Harvard stable. Again, he identified the most important performance criteria as -

- efficiency - both cost and capital
- dependability - delivery and price promise
- quality - the product quality and reliability, service quality, speed of delivery and maintenance quality forming aspects of this criterion. A key factor, Wheelwright believed, is how the market evaluates quality
- flexibility - changes in products and volumes

He introduced a framework which illustrates the need to identify corporate strategy in a context of its resources and industry environment and through the performance criteria arrive at decisions in manufacturing concerning the important areas of responsibility within this function. Some of these are below while a full list is given in Appendix A.2 -

- processes
- capacity
- plants
- vertical integration
- infrastructure

Furthermore, he introduced an important refinement, that of weighting each criteria from a total of 100 points as illustrated in Appendix A.3. However, the use of this discriminating procedure was used by Wheelwright to show discrepancies between a number of vice-presidents within a company and the manufacturing manager in terms of current and required priorities for operations. Later, a similar exercise was carried out involving just manufacturing department heads. The result was to "identify a number of areas in need of a change in emphasis so that manufacturing and its performance priorities would be more supportive of the corporate strategy" (Wheelwright, 1978, p64-5). In the same article, Wheelwright also outlined the procedure to be used in the "application of manufacturing criteria by corporate manufacturing staff" for each business unit. Through the medium of the performance criteria already detailed, the procedure identified major operating decisions and their relative contributions to improving business performance. Appendix A.4 provides details of the procedural steps as detailed by Wheelwright from his research.

2.3 NEW PERSPECTIVES IN MANUFACTURING STRATEGY

During the 1970s, although there were not many contributions to the field of manufacturing strategy there emerged several new dimensions which were critical in themselves and also added to the overall significance of this area. In addition, they all reinforced the argument that a company needed to develop the strategic inputs from manufacturing as an integral part of corporate strategy formulation and that this should then form the basis for selecting appropriate process and infrastructure investments. Without this context it has become increasingly clear from my own research that the resulting vacuum then became the target for a rafter of solutions chosen, by definition, without strategic context and perceived as panaceas irrespective of market need and the firm's requirements.

In 1974, Skinner developed his arguments concerning the focused factory. These perspectives emanated from a need to recognise that factories, facing markets the relevant dimensions of which had typically and significantly changed, could not "perform well on every yardstick". And, though changing markets had led to changing competitive forces the strategic issues being addressed within manufacturing still did not reflect this fundamental difference. He powerfully argued that the problem which companies needed to address was not "how can we increase productivity?" but "how do we compete?" This stark observation challenged and continues to challenge many firms' (and manufacturing function's) view of what constitutes the relevant role of production within an organisation's current corporate strategy. To this he added a further three "basic changes" (Skinner, 1974, p117)

- "seeing the problem as encompassing the efficiency of the entire manufacturing organisation and not only the efficiency of the direct labour or the workforce." (In most plants, direct labour and the workforce represent only a small percentage of the total costs).
- "learning to focus each plant on a limited, concise, manageable set of products, technologies, volumes and markets"
- "learning to structure basic manufacturing policies and supporting services so that they focus on one explicit manufacturing task instead of on many inconsistent, conflicting, implicit tasks"

His conclusions were that "a factory that focuses on a narrow product mix for a particular market niche will outperform the conventional plant which attempts a broader mission .... such a plant can become a competitive weapon because its entire apparatus is focused to accomplish the particular manufacturing task demanded by the company's overall strategy and market objectives".

In this same paper Skinner recognised the need for different manufacturing policies to meet the demands of different products and, within this context, restated some of the elements within production which would constitute a firm's manufacturing strategy. The list he suggested is detailed in Appendix A.5 and covers the prinicipal elements of a manufacturing function's set of responsibilities.

The second development of significance within this decade came from the work of the Boston Consulting Group (BCG) (1972) and concerns the phenomenon of experience curves. The BCG provided evidence to show that as experience accumulates, performance improves, and the experience curve is the quantification of this improvement. The basic phenomenon of the experience curve is that the cost to manufacture a given item falls in a regular and predictable way as the total quantity produced increases. As can be readily appreciated, this relationship offered an important dimension to the formulation of manufacturing strategy. It enabled companies to evaluate and anticipate reductions in cost as the characteristic pattern is that the cost declines (in constant £s) by a consistent percentage each time cumulative unit production is doubled.

The final substantial contribution to the development of concepts within this field came from the Hayes and Wheelwright (1979) article entitled "Linking Manufacturing Processes to Product Life Cycles". The title provides an insight into the particular dimensions addressed here. It took the concepts of trade-offs within manufacturing processes and related them to varying market needs as exemplified by the product life cycle as a way of illustrating the importance for a business of linking the choice of manufacturing process to the market characteristics to its products. Figure 2.3 is a reproduction of the relevant exhibit from their article by which they illustrated the "matching of major stages of product and process life cycles".

The article also gives an example of the use of this concept (see Appendix A.6) and explores "three issues that follow from the product-process life cycle"

- the concept of distinctive competence
- the management implications of selecting a particular product-process combination, considering the competition
- the organising of different operating units so that they can specialise on separate portions of the total manuacturing task while still maintaining overall coordination

My own research in the area of manufacturing strategy had commenced in the late 1970s. By the early 1980s I had summarised many of my views on manufacturing which reflected the tenor and arguments of the early contributors referred to in this chapter. As the field was still virgin territory and, as contributors such as Skinner, Hayes and Wheelwright had provided outline maps offering some directions, then there were many opportunities to undertake relevant research.

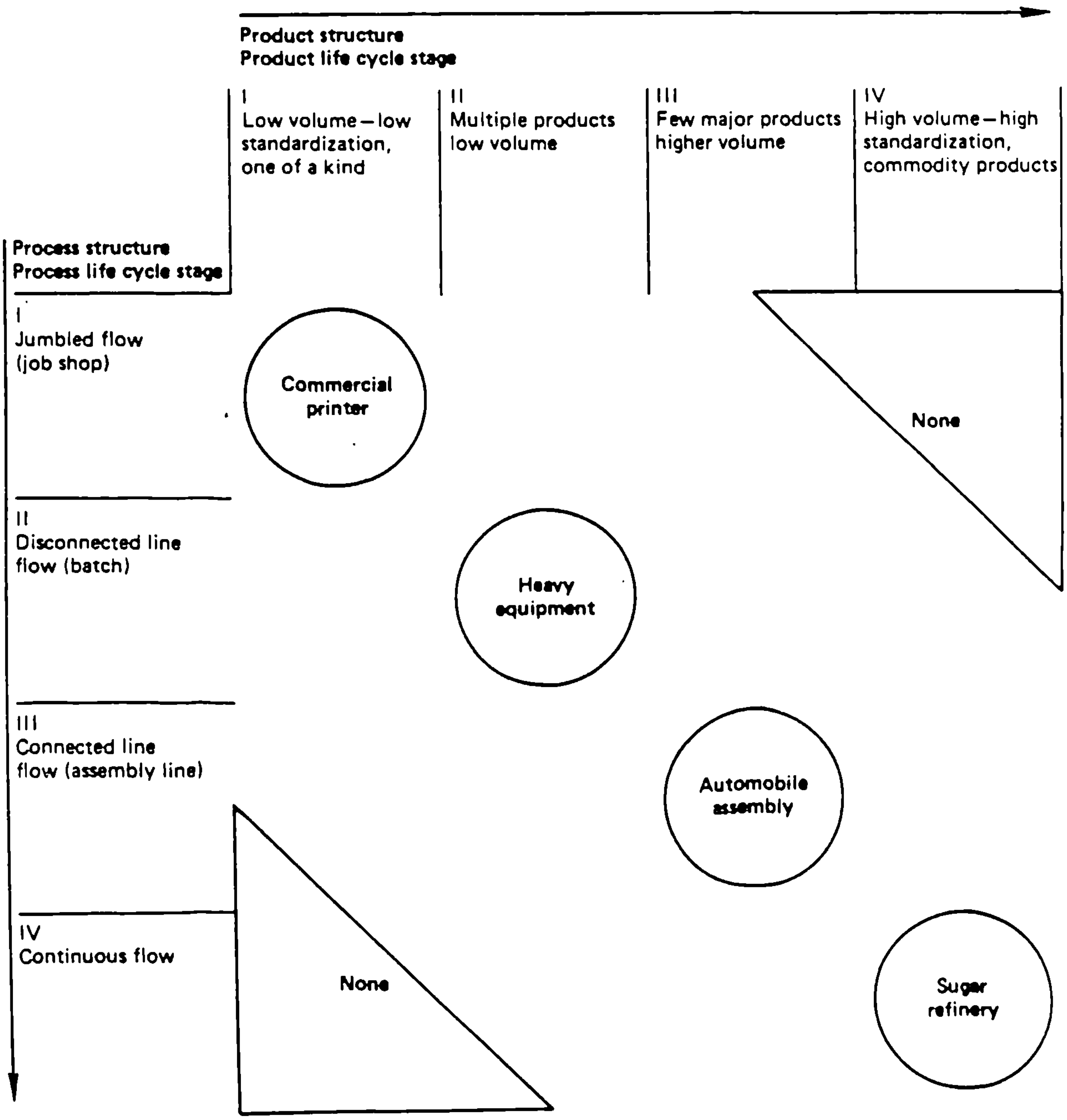


Figure 2.3 Hayes and Wheelwright's exhibit to illustrate the "matching of major stages of product and process life cycles" (1979, p135)

2.4 DEVELOPMENTS IN MANUFACTURING STRATEGY AS PART OF THE OUTPUTS OF RESEARCHERS WORKING IN OTHER AREAS

This section assesses on the work of other researchers in related fields in terms of the extent to which they contributed to or highlighted the need for developments in manufacturing strategy. The purpose of this review was principally to check other potential research sources in order to provide a more complete picture. As Figures 2.4 and 2.5 illustrate, a review of several articles and books in the areas of marketing management, strategic marketing and corporate strategy revealed that little mention was made of the manufacturing function itself, let alone contributions to or identifying the need for developments in manufacturing strategy. Porter (1980) gave most space to manufacturing-related issues. However, while these addressed the important areas of "buyers and suppliers", "vertical integration" and "capacity", the issue of the manufacturing/marketing interface was not part of what was covered. The only other author (Aaker, 1988) in this review to devote a sizeable space to manufacturing confined much of what he included to the aspect of experience curves.

The spread of articles and books reviewed covered the pre and during periods of the research. But, as Figures 2.4 and 2.5 show, the level of coverage was consistently low throughout the whole period.

Author (date)	Number of		
	chapters	pages	
		total	re manufacturing
Marketing Management			
Kotler (1984)	24	794	1.5
Frain (1986)	24	510	1
Oliver (1986)	23	425	1
Poliwoda (1986)	18	308	0
Watkins (1986)	9	161	0
Stern et al (1989)	13	514	0
Total	111	2712	3.5
Strategic Marketing			
Johnson (1971)	-	6	0
Kotler (1977)	-	9	0
Levitt (1977)	-	19	0
Schoeffer (1977)	-	6	0
Abell (1978)	-	5	0
Choffray and Lilian (1978)	-	13	.5
Oxenfeldt and Moore (1978)	-	6	0
Kotler and Singh (1981)	-	12	0
Boyd and Larreche (1982)	-	10	0
O'Shaughnessey (1984)	17	372	0
Weitz and Wensley (1984)	30	500	0
Kotler (1986)	12	292	8
Total	59	1250	8.5

Figure 2.4 An analysis of a number of books and articles in marketing management and strategic marketing in respect of the orientation towards manufacturing-related issues

Author (date)	Number of		
	chapters	pages	
		total	re manufacturing
Hofer and Schendel (1978)	8	219	0
Galbraith and Nathanson (1978)	10	155	0
Porter (1980)	16	396	55
Glueck and Jauch (1984)	10	875	1.5
Hax and Majluf (1984)	21	466	4
Ansoff (1987)	19	284	3
Below et al (1987)	10	136	0
Aaker (1988)	18	364	19.5
Morrisey et al (1988)	9	130	0
Quinn et al (1988)	16	998	0
Total	137	4023	83

Figure 2.5 An analysis of a number of books in the field of corporate strategy in respect of the orientation towards manufacturing-related issues

2.5 A SUMMARY OF THE DEVELOPMENTS BEFORE THE START OF THE RESEARCH

In very broad terms the work up until the start of my research can be summarised as follows -

- Some traditional manufacturing companies had increasingly been out-performed by others
- There was an increasing need for the manufacturing function to play its relevant part in corporate strategy decisions given the changing nature of markets and the fixed nature of manufacturing investment
- When companies invested in manufacturing (either process or infra-structure) there were trade-offs which needed to be understood

- Markets which were different and also changing. There was a need therefore to link what manufacturing could do well (or what it would be able to do well) with appropriate investment to the appropriate market need.

One key theme emering from the literature was that the essential linkage between the principal functions in a business was not adequately undertaken in corporate strategy development. Although my personal research has extended into several areas within manufacturing, the core of the research with regard to this thesis centres on this issue and addresses two perspectives -

- How does a firm provide meaningful linkage between manufacturing and marketing?
- Are there ways of illustrating past, current and/or future mismatches between the characteristics of a company's markets and those of its manufacturing investments?

In the chapters which deal with my research findings, I will link my own work to that of the early contributors detailed in this chapter and also the continuing work of these and other contributors throughout the 1980s. In this way, it is hoped, to illustrate areas of similarity and difference as well as showing how manufacturing strategy, as a field of study, has continued to develop.

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APPENDIX A

EARLY (PRE-RESEARCH START) WARNINGS OF AND INSIGHTS INTO THE NEED TO CHANGE MANUFACTURING'S STRATEGIC CONTRIBUTION

Appendix A provides more detailed material from the work of the principal contributors in the manufacturing strategy field upto 1980. As with other appendices, it has been placed here rather than in the body of the dissertation in order to increase the narrative flow in a chapter. A short description or detailed heading preceeds each part of each appendix in order to provide appropriate context. Finally, all material within this appendix is prefixed with the letter A to indicate that it is part of this particular aspect.

APPENDIX A.1

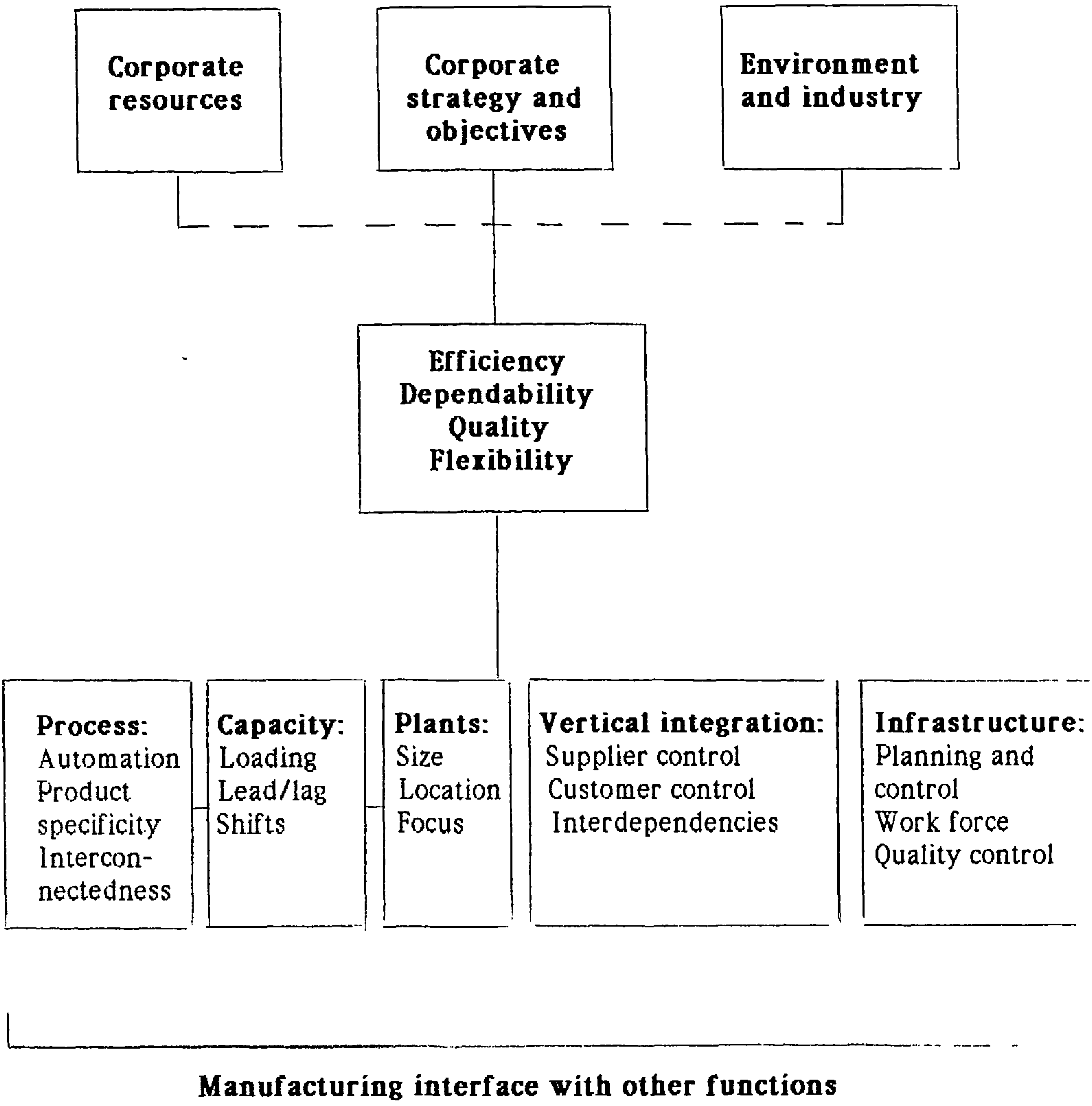
SKINNER'S LIST OF THE TYPICAL OUTMODED CONCEPTS OF MANUFACTURING'S CORPORATE CONTRIBUTION

Skinner (1966)lists the characteristics of the "already outmoded concept of production" (p139) as follows -

- Long runs
- Stabilised engineering designs
- Concise product lines
- Repetitive operations by each worker
- A high proportion of the total costs spent for direct labour
- Intensive use of labour standards and incentives
- Many identical machines in the factory
- Batch process, job-shop layout, disconnected flows, and a substantial amount of materials handling done by employees
- Industrial engineering based on breaking a job down into its parts
- Production management selected and promoted largely on the basis of experience and proven supervisory talents

APPENDIX A.2

WHEELWRIGHT'S FRAMEWORK FOR LINKING CORPORATE DIMENSIONS THROUGH KEY PERFORMANCE CRITERIA TO COMPONENTS OF "MANUFACTURING STRATEGY AND OPERATING DECISIONS"



APPENDIX A.3

EXAMPLE PROVIDED BY WHEELWRIGHT OF PERFORMANCE CRITERIA DIFFERENTIATION BY ALLOCATING PERCENTAGE WEIGHTINGS

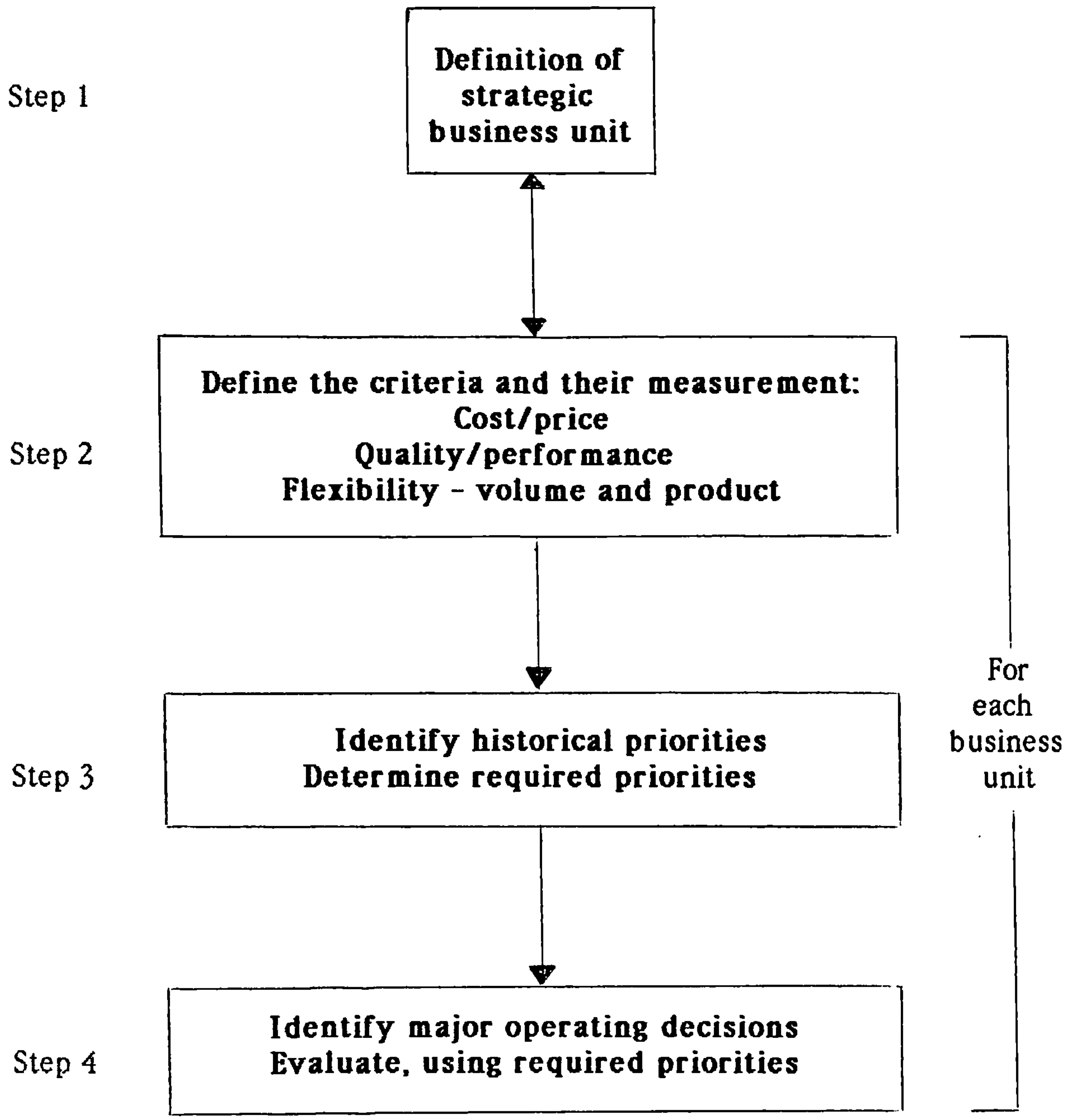
The table below constitutes the "Current and required priorities as assessed by vice-presidents (VP)* and manufacturing managers*."

	Cost		Quality		Dependability		Flexibility	
	VP	MM	VP	MM	VP	MM	VP	MM
PRODUCT 1								
As is	42	44	17	15	25	26	16	15
Should be	28	46	24	16	31	26	17	12
Needs more (less)	(14)	2	7	1	6	0	1	(3)
PRODUCT 2								
As is	26	20	37	43	24	22	13	15
Should be	26	30	36	38	26	20	12	12
Needs more (less)	0	10	(1)	(5)	2	(2)	(1)	(3)
PRODUCT 3								
As is	34	36	27	28	23	19	16	17
Should be	34	38	29	24	24	20	13	18
Needs more (less)	0	2	2	(4)	1	1	(3)	1
PRODUCT 4								
As is	24	34	30	22	19	17	27	27
Should be	39	44	20	25	23	15	18	16
Needs more (less)	15	10	(10)	3	4	(2)	(9)	(11)
PRODUCT 5 (Parts)								
As is	45	37	21	14	18	31	16	18
Should be	22	31	24	13	35	35	19	21
Needs more (less)	(23)	(6)	3	(1)	17	4	3	3

*Criteria totals for VP and MM for each priority = 100

APPENDIX A.4

WHEELWRIGHT'S PROCEDURE FOR IDENTIFYING MANUFACTURING STRATEGY DECISIONS FOR EACH BUSINESS UNIT



APPLICATION OF MANUFACTURING CRITERIA BY CORPORATE MANUFACTURING STAFF

APPENDIX A.5

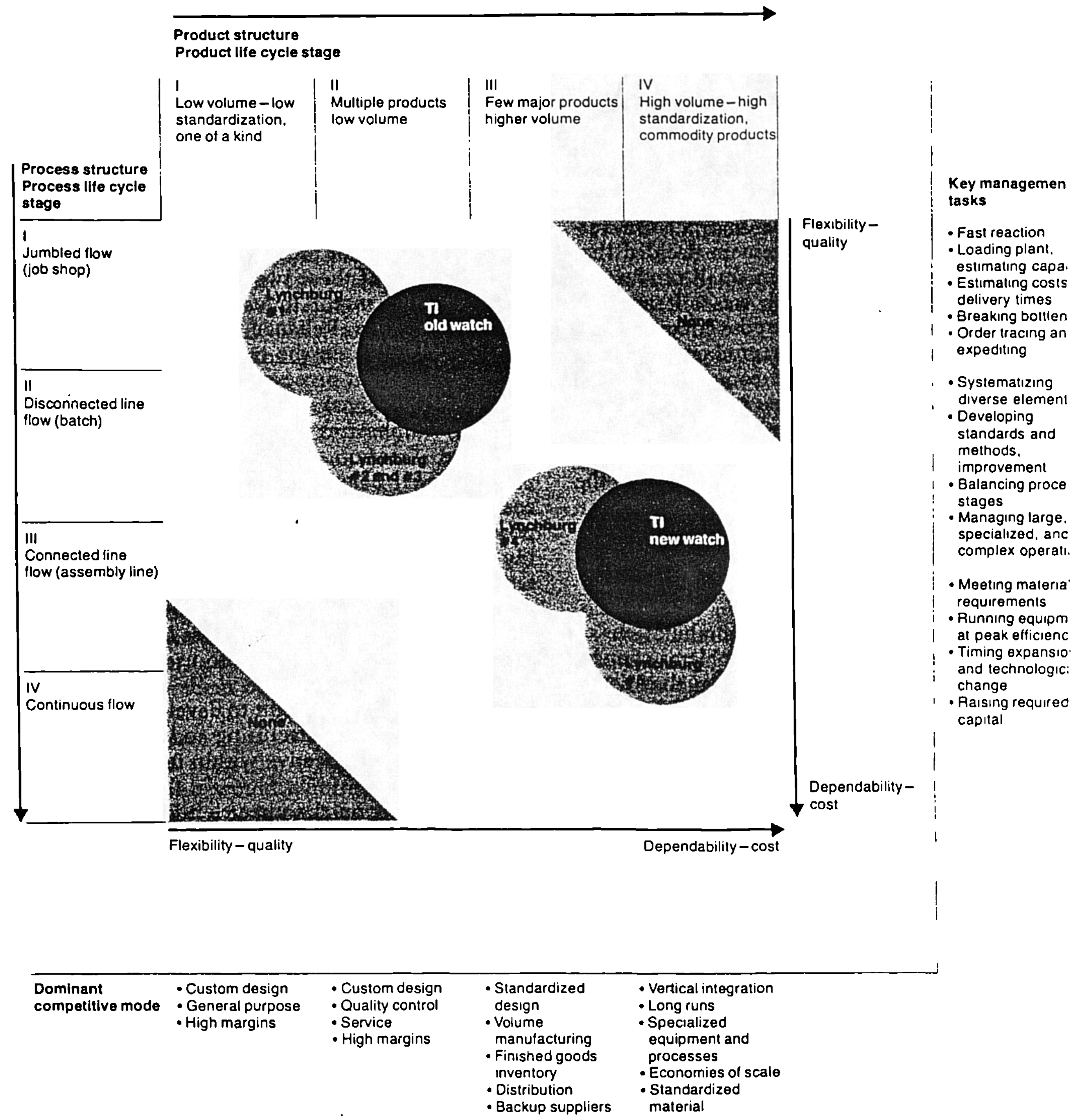
SKINNER'S LIST OF SOME OF THE ELEMENTS OF MANUFACTURING POLICY

- Size of plant and its capacity
- Location of plant
- Choice of equipment
- Plant layout
- Selection of production process
- Production scheduling system
- Use of inventories
- Wage system
- Training and supervisory approaches
- Control systems
- Organisational structure

APPENDIX A.6

ILLUSTRATION PROVIDED BY HAYES AND WHEELWRIGHT ON THE USE OF "PRODUCT - PROCESS MATRIX"

Expanded product – process matrix



3 METHODOLOGY

3.1 INTRODUCTION

Undertaking research in a field which is substantial in nature and yet where at the time relatively few major developments had been made has, like any other situation, its own mix of trade-offs. Whilst the opportunity to complete research which may be central to some of the major issues is relatively high, tried and tested approaches will be understandably small in number and short on rigour.

At the start of the research programme, manufacturing strategy fell into this type of scenario. Most of the key researchers had at the time explained little about the methodologies they had used and what refinements, if any, would need to be made in general or with regard to specific fields of research or particular manufacturing sectors or firms.

The need for research was clear. The fact that the role of manufacturing was, in part, to provide a functional response on how best to meet the requirements of a business was agreed. Typical issues and key facets of this functional statement had also been identified and, amongst some of the key researchers at the time, there was a measure of agreement on what these dimensions should be, as illustrated in Appendix B.1.

But, how these were to be identified and the way in which relative importance was to be established had not been articulated. However, agreement upon some of the key issues involved and the important dimensions to be addressed had focused attention upon the link between the market and the nature of the manufacturing investments undertaken to support these. In itself there is nothing startling in these issues. Their relevance, therefore, concerned the fact that the research work had confirmed perspectives which could be arrived at both intuitively and logically. Intuitively in that the very essence of strategy concerns functional linkage to the market place. Logically because the raison d'etre for manufaturing investment is to help a company to become more competitive.

3.2 RESEARCH METHODOLOGIES - ALTERNATIVES AND CHOICES

There are a range of research designs and methods which may be used to undertake research into management-related fields of study. This section briefly outlines the more important of these and concludes with an explanation of why the methodology adopted was chosen.

3.21 RESEARCH DESIGNS AND METHODS OF DATA COLLECTION

Research designs concern the overall structure and orientation of the research investigation (Bryman (1989). It thus provides a structure within which data can be collected and analysed. Although several structures and data collection methods are associated one with another, this is not always so. For this reason, therefore, a distinction will be drawn between these two aspects of research methodology.

a) Research designs

1 **Experimental research** : this comprises laboratory and field experiments. Orpen's (1979) study illustrates the basic framework of an experiment. There are two or more groups involved - in his work, one was given enriched work and the other not. In this way the latter acts as a datum point for comparison. Research work of this kind needs to be undertaken in controlled conditions which implies the elimination

of alternative explanations of the observed outcomes.

2 **Survey research** : in this method of research, data are collected, usually by interview or questionnaire, on a range of variables. The objective then is to assess both the importance of particular facets and to identify relationships between two or more variables. The degree of causality has to be inferred. Unlike experimental research, the researcher does not intervene in an organisation.

Most survey-based researach collects data at a single point in time. Where further questioning of respondents takes place then the research takes on the form of a longitudinal survey.

3 **Qualitative research** : advocates of qualitative or interpretive methodologies hold misgivings about the scientific pretensions of quantitative research (Downey and Ireland, 1979). While both quantitative and qualitative research designs typically contain elements of each approach, what distinguishes them is that in the latter, the emphasis tends to be on an individuals' interpretations of their enrivonment and on their own and others' behaviour and on understanding what is going on in organisations in participant's own terms rather than those of the researcher.

4 **Case study research** : case studies entail the detailed study of one or a small number of cases. The units of anlalysis is the business or part of a business. What distinguishes this design from qualitiative research is the review of relevant data as a principal course of understanding and definition.

Researchers can select as their basis of analysis a single plant or business multiple case studies. The former provides a detailed review of relevant research issues aimed at agreed objectives. In multiple case study-based research, detailed information is gathered at several sites. In analysing the data, similarities and differences are noted to form the basis of research evidence concerning relevant issues and objectives.

5 **Action research** : in action research both the researcher and members of the organisation being studied are involved in dealing with an acknowledged problem. The researcher structures arguments and perspectives and helps those involved to identify preferred courses of action to follow. The impact of implementing the agreed actions are observed as part of the field of study.

b) Methods of data collection

Within these designs, several methods of data collection may be used. As explained earlier, some designs are associated with certain data collection methods while others typically use two or more approaches as part of the research investigation. The sections which follow outline the principal methods

1 **Self-administered questionnaires** : this method requires participants to complete a collection of questions on their own and without the opportunity to discuss or clarify any aspects embodied in the questionnaire.

2 **Unstructured interviews** : interviews are undertaken in an informal style in that respondents are allowed considerable latitude in the aspects addressed in the discussion. There may even not be a predetermined set of questions or aspects to be systematically discussed during an interview.

3 **Structured interviews** : unlike the last method, structured interviews comprise specific and precisely formulated questions around which discussion is built.

4 **Observation** : the researcher observes relevant activities within an organisation in either a structured or unstructured format.

5 **Archival information analysis** : this method concerns the systematic analysis of existing materials. Typically, this constitutes prime data which are records of transacations and activities together with contemporary and historical controls and measures of performance per se or derived from source data.

3.22 CHOSEN RESEARCH DESIGNS AND METHODS OF DATA COLLECTION

The alternative research designs and data collection methods embody their own rationale. Sound arguments could, therefore, be made for a number of combinations as being suitable to meet the anticipated outcomes from research into the area of manufacturing strategy. In deciding which approahces to use, it was essential to select research design(s) and data collection method(s) which would highlight the need for the research data to be both relevant and representative. Relevant in terms of reflecting the important issues involved and representative in terms of reflecting the balance and relative importance of the issues addressed.

Given that manufacturing strategy is an applied field of research, the inherent complexity within manufacturing plants does not make investigation easy. And, even more so when the representative and relevant dimensions relate to issues within manufacturing (itself a complex function) and at the strategy level.

On reviewing approaches, therefore, these factors were uppermost in my mind. The eventual choice was based on a case study design and data collection methods which combined structured interviews and the systematic analysis of archival information. The principal reason was that this appeared to be the best way of securing the necessary level of understanding of those areas embodied in this field of research. In fact, the in-depth nature of this type of research appears difficult to secure by alternative data collection methods.

However, the review of alternatives raised one important issue, that of the generalisable nature of the research outcomes. The argument that more broadly based research designs and data collection methods lead to outcomes which are more generalisable in nature is well articulated. The premise for this view concerns the fact that as the research base from which the data is collected is wider then the level of general applicability will tend also to be wider. That case study designs normally have a relatively narrow research base was recognised at the outset. In order, therefore, to test issues (in this instance both methodology and product profiling applications) I decided against using a longitudial base for a small number of case studies and instead elected for an application of the approaches over many more companies (ie multiple case studies).*

In summary then, the major advantages of the research method chosen was that it combined in-depth data collection with generalisability of outcomes. The structured interviews and systematic analysis of archival information provided an effective way of researching the complex areas of manufacturing and strategy. The multiple case studies then in turn redressed, at least in

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* Note - the analysis of company reviews given as Appendix H.1 only identifies core applications. The methodology was, in fact, used in each of the 33 companies and the issues underpinning product profiling were observed in a total of 14 applications.

part, the narrow research base associated with some forms of in-depth and strategy. The multiple case studies then in turn redressed, at least in part, the narrow research base associated with some forms of in-depth research methods. In this way, the trade-off on generalisability was countered whilst the essential need for relevant and representative analysis had been secured.

3.3 INITIAL METHODOLOGY ADOPTED AND USED IN THE FIELD RESEARCH

As is common with other fields, the methodologies used in this research have been modified over time in the light of application and a deeper appreciation of the relevant dimensions involved. However, much of the approach has remained unchanged in philosophy if not in detail and presentation. The underlying feature has been to create the wherewithall to link manufacturing decisions to the marketing strategy of a firm. Consistent with the argument of others in the field (Skinner, 1974; Hayes and Schmenner, 1978 and Wheelwright, 1978) the linking mechanism concerned the "performance criteria" which reflected the nature of competition within the relevant markets of a business. However, conscious even at the early stages of the research that explaining the approach and issues to those involved was of prime importance, a framework was developed to reflect this linkage and to offer a diagramatic explanation of the steps involved (see Figure 3.1).

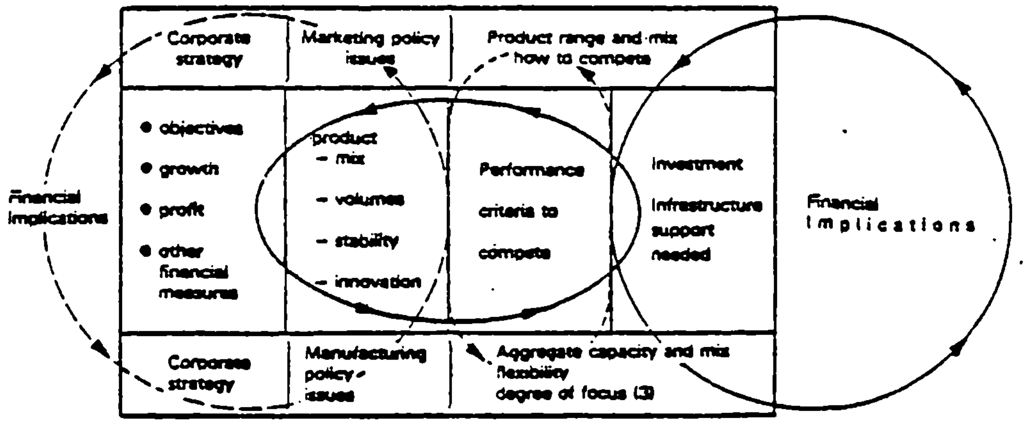

Figure 3.1 Framework to reflect manufacturing strategy issues in corporate decisions

First published by the author in article form in late 1980 (Hill), this provides a formal record of the methodology used at the very start of the research period. In addition to its diagramatic form, the steps to be followed were also detailed in the same article. As with the work of earlier researchers (Skinner, 1974 and Wheelwright, 1978) frameworks and methodologies are an essential prerequisite in the explanation to others and in the understanding by oneself. It was recognised and appropriately stressed in the detail of the narrative of the same article (Hill, 1980) that several important issues needed to be recognised as being critical in these developments. The sections below clearly illustrate this point.

- "Although the steps to be followed are given as finite points in a stated procedure, in reality the process will involve statement and restatement, for several of these aspects will impinge on each other. This has been indicated by the dotted and continuous circles and shapes shown in Figure 3.1. It should not simply be a process of determining the manufacturing implications of stated marketing requirements. To get the best corporate decision different sets of decisions are considered in terms of marketing strategy and the manufacturing implications and financial considerations involved. This process of weighing alternatives against each other will lead to a better corporate judgement, an essential step in the process of determining corporate policy.

- "Manufacturing is concerned with detail. This does not mean that production executives carry this perspective into the corporate debate. It does, however, mean that in order to understand the implications of product change, the detailed implictions of such changes need to be assessed.

  "Whilst acknowledging the need for a broader statement of the manufacturing task it is essential that the implications are analysed in detail. In manufacturing, the building of policy or manufacturing responses to corporate needs is a two-way process; from both the top down and bottom up. Without this two-way approach the process will be of significantly less value." (Hill, 1980, p8)

- In Step 3 of Figure 3.1, "it is necessary to agree the performance criteria which marketing considers necessary to compete effectively. This, like Step 2, is difficult to resolve and, as shown in Figure 3.1 by the oval shape in the centre of the diagram, will be part of a whole series of adjustments and alternatives. Marketing in going through this discussion will be required to differentiate between what is preferred and what is required, and the manufacturing plant and infrastructure investment alternatives will be an important part of that debate. In simple terms, the demands made on manufacturing are a direct consequence of what marketing wants and how it wants it." (Hill, 1980, p9)

- "Some of the performance criteria which may be necessary to compete successfully and hence to be provided to the fullest extent possible are given below.

  (1) *Output-rated performance* - embraces both cost effectiveness and the effective use of capacity and other production investments. This important criterion is concerned with meeting the corporate requirement in terms of cost (and hence price), of which throughput is normally an important ingredient. It would include the investment in the process to bring this about.

  (2) *Delivery performance* - this is both in terms of response to the market demand and the reliability of the delivery promise. It involves decisions on capacity, degree of product standardisation, product

definition, degree of customer orientation in the product and inventory investment throughout the system. The control of the work flow is an important feature of the task but often has significant trade-offs with investment and cost.

(3) *Quality* - product quality and reliability which includes, in certain instances, design and development, manufacture and after-sales service considerations. The cost/quality tie up is an essential and fundamental debate. This aspect also includes features such as changes in technology both in the product and the process.

(4) *Response to product demand* - involves both aggregate and timing considerations related to capacity in terms of how well the manufacturing facilities can respond to sales volume and product mix changes.

- Even though the last point listed some of the performance criteria typically involved and recognised that the application of these on a universal basis across all products was not implied, the need to reinforce difference was clearly identified and articulated in the same article. The following statement which has been taken from the same source and follows on immediately from the last point.

> "the key point here is that different products will demand different types of performance criteria (and different levels within each type) in order to compete successfully within a sector of the market. This in turn will reflect the type of performance support required from the manufacturing function. Over time, however, this will change and consequently will have to be reviewed and revised on a regular basis. How mangeable this proves to be will depend on the range of performance demands which are intended to be placed on the production system Rarely can a company be run solely for manufacturing efficiency or aimed specifically to increase productivity. Similarly, seldom can a company be run to meet a wide range of fluctuating demands from marketing. The theoretical ideal posed for production of running a limited range of products in a few colours and in high volumes and the opposite ideal posed for marketing which reverses these preferences are both far from the reality facing most companies. In many instances the adjustments away from

> these extreme positions have been made intuitively often by a give and take, commonsense mechanism.
>
> "What is advocated here is very different to this informal system which is often epitomised by frustration and accusation. Initially it requires careful and detailed working to test the trade-offs and implications of these performance demands with one another. Then, a check is made on the difference these demands have between the impact on marketing effectiveness and the impact on the overall performance or resultant consequences within the production system. From this a best corporate fit can then be established and worked to. Furthermore the often ad hoc or unilateral decisions which will be made at some future time can now be avoided and resolved, not only in themsleves but within the total corporate framework."
> (Hill, 1980, p10)

Manufacturing strategy is the final outcome of the procedure and concerns "the investment implications of these discussions and the manufacturing infrastructure needed to underpin these decisions. Given unlimited resources in terms of capacity, capability, inventory investment and so on, manufacturing could meet any marketing demands made within the bounds of commonsense. However, there is no way in which this situation could be to the corporate benefit even in the short-term. Consequently in the process of resolving the marketing alternatives to meet the corporate objectives, the financial implications of these options will loom as an important consideration. Strategies of chase or level demand, capacity/capability changes, inventory investment, flexibility within the process, degree of focus or range of product demands made of a manufacturing plant will be discussed and resolved through, amongst other things, the financial considerations involved. In addition, this aspect involves specifying the control systems required and the work force management and labour policies to best support the production system. These again will need to be evaluated in financial investment terms· (Hill, 1980, pp10-11)

3.4 APPLYING THE BASIC METHODOLOGY WITHIN A FIRM

The following sections detail modifications to the original framework (given as Figure 3.1) which were a result of applications within the research process. However, though important, they are refinements rather than fundamental changes to the core of the methodology used throughout.

In this thesis, five plant applications are discussed in detail. Two are in Chapter 4 which concern the application of methodology explained earlier in this chapter and three applications which concern the concepts explained in Chapter 5. However, applications in addition to these five are referred to in this chapter to further illustrate particular points and developments (for example in Appendix C).

The research procedure which was followed constituted a series of steps within the context of the approach embodied in the framework described earlier. This part of the procedure was designed to agree, through discussion and checked by relevant analysis, the different market segments served by a company, the way in which orders were won within each segment, the implications for manufacturing of supporting the relevant criteria and assessing how well the current decisions and approaches within the production function matched this task. The steps, in detail, are as follows

1 Marketing is asked to review the company's business and identify the different segments perceived to exist within each of its markets

2 Marketing is then required to select a number of products which represent the characteristics of each segment. These then form the initial basis for the research analysis to be undertaken.

3 As manufacturing investments are both inherently large and fixed then it is of paramount importance that a company understands the nature of these investments not only in terms of the technology dimenson but also in terms of their business fit. In order to help assess the latter, marketing were asked to review the products in terms of the question "How does the company win orders for a particular product within its market place?"

4 This initial view of the business serves as a mechanism to stimulate debate within a company in terms of its markets and the competitive forces within various segments. In addition, the representative products give direction to the collection of data as part of the testing procedure. The outcome is that the initial views are challenged which invariably leads to the identification of different segments and different criteria for winning orders both in terms of different dimensions and the weighting given to relevant criteria. Illustrations of these outcomes are given in a later section of this chapter.

5 For any new segments, representative products are identified and these now form part of the overall review.

6 The procedure eventually leads a company to have a clearer understanding of its markets, the competive forces which operate within relevant segments and one platform for helping to link the marketing and manufacturing functions of the business.

3.5 APPLICATION LEADING TO CHANGES IN METHODOLOGY

The sections above not only provided an overview of the methodology used in the early applications of the research but also detailed some of the important facets to be emphasised and key features to be recognised in their application.

As with most research, procedures and relative weightings within these approaches were refined with use. Application led to an increased level of clarity between and within issues and highlighted key points which were essential in nature and intrinsic to the conceptual base on which the approach was derived. What follows is a synopsis of the important changes identified. In addition, and where relevant, they are cross-checked to the work of and developments made by other researchers. These, understandably, display differing degrees of similarity with the ones detailed below which represent, in principle, outcomes of the process of applied research.

3.51 THE COMPONENTS OF MANUFACTURING STRATEGY

At the start of the research, while the need to break out the component parts of the manufacturing function was recognised as being an inherent part of the approach, the need to provide structure for the wide range of tasks in manufacturing was not fully appreciated. The simple change was to separate process-related and infrastructure-related aspects as shown in Figure 3.2.

1	2	3	4	5
Corporate objectives	**Marketing strategy**	**How do products win orders in the market place**	**Manufacturing strategy**	
			process choice	**infrastructure**
• growth • profit • return on investment • other financial measures	• product markets and segments • range • mix • volumes • standardisation versus customisation • level of innovation • leader versus follower alternatives	• price • quality • delivery speed reliability • colour range • product range • design leadership	• choice of alternative processes • trade-offs embodied in the process choice • role of inventory in the process configuration	• function support • manufacturing systems • controls and procedures • work structuring • organisational structure

Note: Although the steps to be followed are given as finite points in a stated procedure, in reality the process will involve statement and restatement, for several of these aspects will impinge on each other.

Figure 3.2 Revised framework for reflecting manufacturing strategy issues in corporate decisions (Hill, 1981)

The nature of this refinement was more subtle than fundamental. However, it provided clearer insights when explaining the research approach whilst demanding a higher level of clarity within the research process itself. An example of this important clarifying process is provided by the positioning of inventory (often associated with infrastructure provision) within the segment of process-related investments. It became clear that inventory has a distinct relationship to the choice of process in that it "oils the wheels" of manufacturing by facilitating the process involved to meet the needs of the business. Developments of this kind took place throughout the period of research and were eventually identified as sub-headings within the process-related and infrastructure-related steps as shown in Figure 3.3. In the early stages of the research Steps 4 and 5 in Figures 3.2 and 3.3 were not part of the diagrams used but formed part of the narrative of articles or as part of the explanation within an organisation. In both instances, narrative was necessary to support the broad statements given in Figure 3.2, rather than being provided as explicit detailed points shown in Figure 3.3 (Hill, 1989).

Corporate Objectives	*Marketing Strategy*	*How Do Products Win Orders in the Market Place?*	*Manufacturing Strategy*	
			Process Choice	*Infrastructure*
Growth Survival Profit Return on investment Other financial measures	Product markets and segments Range Mix Volumes Standardization versus Customization Level of innovation Leader versus follower alternatives	Price Quality Delivery speed reliability Demand increases Color range Product range Design leadership Technical support being supplied	Choice of alternative processes Trade-offs embodied in the process choice Process positioning Capacity size timing location Role of inventory in the process configuration	Function support Manufacturing planning and contro systems Quality assurance and control Manufacturing systems engineering Clerical procedures Payment systems Work structuring Organizational structure

Note: Although the steps to be followed are given as finite points in a stated procedure, in reality the process will involve statement a restatement, for several of these aspects will impinge on each other.

Figure 3.3 Framework for reflecting manufacturing stategy issues in corporate decisions (steps involved)

Other researchers in the field had similarly modified their original statements concerning the approach to developing a manufacturing strategy whilst additional insights were being put forward by others.

Skinner's research (1985) confirmed the problem of developing focused manufacturing strategies as including the"excessively general" nature of the manufacturing task which fails to "clearly state its implications and its disclaimers (ie what we will not do)." In this book he also provides the detailed stages in the development of a manufacturing task from the initial "collection of goals" to the phase of where "the name of the game is explicit". Also provided are examples of "explicit" targets for manufacturing against the criteria of cost, quality/reliability, delivery performance, asset utilisation and employee relations (Skinner, 1985, pp88-9) , a list similar to that highlighted in his earlier statements. Throughout, Skinner, as before, emphasised the need for a manufacturing organisation to "explicitly identify its manufacturing task - to be explicit with and supportive of the corporation's competition strategy and then organise manufacturing structure to accomplish a sharp focus for that task" (Skinner, 1989, p95). In addition, he supported this statement of requirements by advocating a more detailed review of the components of the design of a production system in terms of

- What to make and what to buy, ie the integration issue
- Production planning, scheduling and inventory contol
- Workforce management
- Quality control
- The formal organisation
- Controls, reports and information systems
- Purchasing

In turn, these seven dimensions were given further detail by Skinner in his "manufacturing audit checklist process" an outline of which is given in Appendix B.2 (Skinner, 1985, pp95-101).

Two other notable researchers (Hayes and Wheelwright, 1984) also provided a major contribution with their book entitled "Restoring our Competitive Edge". Many of their earlier statements on the methodology for developing a manufacturing strategy were reinforced, for example, Table 2.1 on p31 gives a list of the manufacturing decision categories similar to those contained in their earlier work. However, they clearly stress the need to recognise that strategy responses for individual businesses will often (and appropriately) be different from one another thus reflecting the different business strategies which exist. The idea of developing a common manufacturing strategy implies that all businesses within a company are similar. Hayes and Wheelwright understandably query this and set to one side the logic of this notion (1984, pp33-35).

In addition to the work of early researchers, contributions were also made by a number of others in the field. Many played a useful role at the forefront of developments in the production/operations management field. Other contributors put forward more prescriptive alternatives as a view of strategy and argued for the application of approaches which had been successfully applied elsewhere. These solution-orientated arguments were panacea-driven which could take the form of supporting particular techniques or systems or particular approaches or philosophies. Details of these contributions are addressed at the beginning of the next chapter as a prelude to the analysis phase of the dissertation.

Some of the major statements tended more to re-state existing proposals and approaches in the field. Buffa (1984) for instance reinforced existing content statements by listing the components of manufacturing strategy· Gunn (1987), on the other hand, challenged Hayes and Wheelwright's statement of manufacturing strategy content and argued that "today's manufacturing strategy objectives" comprised ones of performance as illustrated in Figure 3.4 on the next page.

The difference, however, between these lists is one of content rather than approach. Hayes and Wheelwright identify the principal functions of production whereas Gunn identifies a mix of outcomes to be achieved. However, both argue that manuacturing strategy should comprise a strategic statement for each item in the list (whether the review of a function or the achievement of an outcome). The approaches to manufacturing put forward by both are similar in that they comprise a view of the major components of manufacturing and that each of these, in turn, needs to be addressed as part of the formulation. The essential nature of manufacturing strategy, however, as perceived through my research is derived from the need for a company to first understand its markets. Until this has taken place the key differences (and hence the key tasks within manufacturing) cannot be identified. Only with these insights can companies understand the relevance of their current and past process and infrastructure investments and identify the key tasks to be undertaken - those which constitute the essence of strategy for this function.

Manufacturing Strategy	
Classic factors	Today's objectives
Capacity Facilities Technology Vertical Integration Workforce Quality Production planning/ materials control Organisation	Shorter, new-product lead time More inventory turnovers Shorter manufacturing lead time Highest quality More flexibility Better customer service Less waste Higher return on assets

Figure 3.4 Gunn's view of the change required in setting suitable manufacturing strategy objectives

3.52 KEY ROLE OF PERFORMANCE CRITERIA

In the businesses researched, the steps which they undertook to develop a corporate strategy principally consisted of Steps 1 and 2 of Figures 3.2 and 3.3 given earlier on pages 66 and 67 respectively. Whether by Group head office decree or expectation, internal derivation or a combination of the two, companies formalised a statement of their objectives (see Step 1, Figures 3.2 and 3.3). The next (and appropriate) step is to turn to the marketing function and seek a statement of its strategy to achieve this. Typically, this manifests itself as a build up of forecast sales revenue (Step 2, Figures 3.2 and 3.3) which becomes the basis for potentially achieving the performance-related objectives set in Step 1. In all the companies researched these steps were undertaken and an iterative debate not only linked the two stages but also ensured a fuller understanding of the issues involved in this corporate marketing phase. The problem was that for most firms, this is where the strategy debate ended. The assumption was that manufacturing could support these corporate marketing decisions. The difficulty was, therefore, how to introduce the dimensions of manufacturing into the corporate strategy debate at the right time and the right level.

The key to this was the role of the performance criteria. Securing an understanding of how a company won orders in its respective market segments provided a mechanism for bringing the functions of a business (and particularly marketing and manufacturing) into common debate - see Figure 3.5 which is based on an outline version of Figure 3.4.

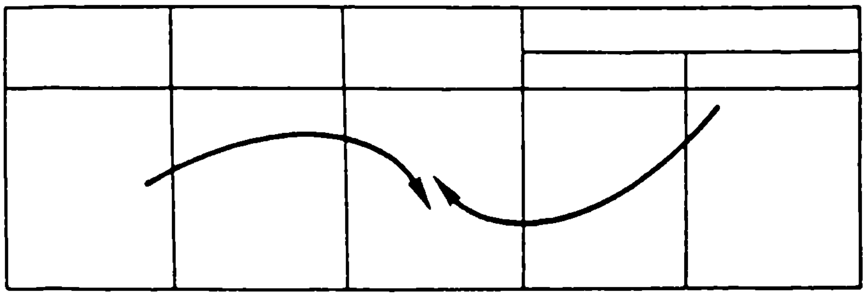

Figure 3.5 How order-winning criteria link corporate marketing decisions with manufacturing strategy (Hill, 1985, p44)

- For marketing, it focuses appropriate attention on a firm's markets while adding new perspectives to those classically held by this function

- It enables manufacturing to ask marketing questions about the company's markets which required manufacturing answers

- For the firm it offers the chance to bring two of the principal functions together and provides a mechanism enabling these key parts of a business to replace functional arguments with corporate debate and to resolve functional disagreement by settling differences at the next higher level in the organisation, that of the business. In this way, it enables companies to agree an outcome where functional perspectives characteristically differ by establishing what was best for the business as a whole. In this way, an agreed set of decisions are made providing common rules for the business as a whole. In turn, this helps set aside differences, improves the quality of corporate strategy decisions and enables the principal players to conduct their functional debate and undertake their functional decisions in a business context and using the same set of rules. Singing off the same hymn sheet is found to help keep corporate performance in time.

3.53 DIFFERENT ROLES OF PERFORMANCE CRITERIA

Applications of the framework brought a recognition of the need to distinguish between performance criteria both in terms of their different roles and levels of importance.

- **order winners and qualifiers** - when businesses discussed the question "How do products win orders in their market place?" it became apparent that the role of some criteria differed one with another. This realisation was also part of a recognition that the failure by companies to clarify their markets was one fundamental factor in their inability to determine corporate strategies which were multi-functional in origin, sensitive to segment differences and built to support the particular performance criteria within each facet of a business. Part of these role differences was explained by the separation of two sets of criteria (Hill, 1984)

  - **qualifiers** which get a product into and maintain a product within a market

- **order-winners** which, having qualified, are those criteria which have to be provided to win an order from competitors who have also qualified

The use of these distinctions facilitates discussion on markets and enables companies to separate segments one from another as they become sensitive to performance criteria differences. Key characteristics included

- qualifiers get a company into and maintain it in a market but do not win orders
- qualifiers, therefore, have order-losing rather than order-winning characteristics
- not all order-winners are manufacturing-related (eg design and after-sales service)
- however, as a product goes through its life cycle then typically order-winners become increasingly a manufacturing task (eg price and delivery speed)

• **relevant criteria weightings** - initial applications attempted to distinguish the relative importance of criteria by asking firms to award none through to three stars reflecting low to high importance. However, it soon became clear that this was unsatisfactory because it failed to force those involved to distinguish clearly, through debate and anlysis, the relative importance of criteria. As the source of stars was endless the result was that relative importance was not identified as too many issues were identified as being important. The distinction between qualifiers and order-winners was a first step. A second, was to require a company to distribute 100 points between the order-winning criteria involved. In this way companies were forced to distinguish the relative importance of different order-winners. Finally, it became important to identify any qualifers which were order-losing sensitive. These were aspects of a market segment which, if the company failed to continue to provide (ie to continue to qualify) would be more sensitive in terms of being order-losing than other qualifers. An example of the detailed outcome is given as Figure 3.6 with further illustrations provided as Appendix C.1

Order-Winning and Qualifying Criteria	Product, Time-Scale, Order-Winners, and Qualifiers								
	Product A			Product B			Product C		
	1985	1986	1988	1985	1986	1988	1985	1986	1988
Design capability	—	—	—	40	—	—	—	—	—
Handling design modifications	—	—	—	—	20	—	20	—	—
Technical liaison support	—	—	—	20	20	—	20	—	—
Nationally based supplier	10	—	—	10	10	10	20	—	—
Existing supplier	10	60	90	10	20	30	—	30	30
Price	60	40	10	20	30	60	30	40	40
Delivery speed	20	—	—	—	—	—	10	30	30
Delivery reliability	QQ	Q	—	—	QQ	QQ	QQ	QQ	QQ
Quality	Q	Q	Q	—	QQ	Q	Q	Q	Q
Weekly volumes	2500	1500	50	—	300	700	3000	4000	4000

Note: Q denotes a qualifier and QQ an order-losing sensitive qualifier.

Figure 3.6 The Weekly volumes, order-winners and qualifiers for products considered representative of the three product ranges

3.54 PHASES IN MANUFACTURING STRATEGY DEVELOPMENT

The last set of developments concerned the phases in manufacturing strategy formulation. Figure 3.7 (Hill, 1985, p52 and Hill, 1989, p47) reinforces the iterative nature of manufacturing strategy developments which concerns identifying the relevant order-winners and qualifiers for each segment and then testing the level of support for the current and future criteria to be provided by manufacturing. This checking process identifies the level of support required and the areas where current and past decisions need to be modified in terms of both process and infrastructure investments.

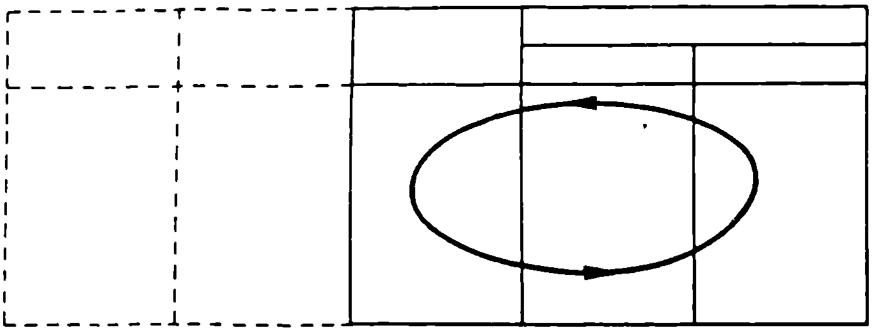

Figure 3.7 Assessing the implications for manufacturing processes and infrastructure of order-winning criteria

However, as shown by Figure 3.8 (Hill, 1985, p55 and Hill, 1989, p50) there is also a need to link the marketing and manufaturing strategy decisions together, an interface which concerns the debate about the business itself. This is one of the outcomes of developing a manufacturing strategy and is principally designed to provide part of the essential corporate check on the levels of consistency between the functional strategies of marketing and manufacturing and to enable differences to be discussed and resolved within the context of the business as as whole.

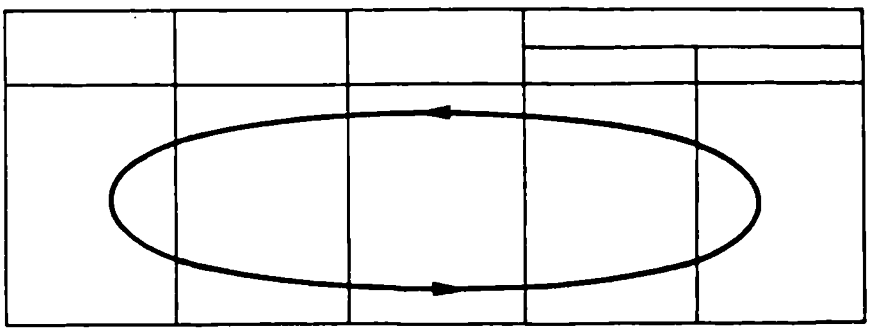

Figure 3.8 Manufacturing's input into the corporte strategy debate

3.6 EXAMPLES OF APPLYING THE FRAMEWORK, THE NATURE AND PURPOSE OF THE DATA COLLECTION AND TYPICAL OUTCOMES

Although the core of Chapter 4 provides two examples and outcomes from applying the methodology outlined earlier in this chapter, it is opportune to give a flavour of how the framework was applied, the data collected and typical outcomes in order to enhance the explanations used throughout the research. What follows, therefore, are illustrations from the research which will be described from a methodological point of view with the aim of providing additional explanation while offering context for the next chapter. Also, earlier in this chapter I explained that I would draw upon other plant-based applications to further illustrate some of the points raised here.

As explained before, the key steps followed were -

- Marketing needs to provide a view of the segments served by the business, products which represent each segment and time scales which reflect the life cycles of these products/segments

- In addition, marketing also needs to identify the performance criteria (order-winners and qualifiers) for each of those representative product groups together with relative weightings over agreed time periods

The purpose of this is to offer the firm a view of its business by that function which typically is more concerned with customer-related perspectives, and for this to be the start of a debate about the company's markets. What follows is a discussion which is intended to check, modify and agree the different segments served by the business and what competing effectively in each of these means (including discussion and additional analysis).

This procedure although apparently simple in nature usually takes between two and four months to complete. In fact, it is now apparent that the need to allow adequate calendar time is a feature of strategic development which should not be short circuited. It is essential to allow adequate debate, and thinking time besides analysis. The stimulus for discussion is from three sources -

- The initial statements by the marketing function in terms of segments, order-winners, qualifiers and time scales
- The counter (or confirming) views of other functions
- Analyses relating to the performance criteria and based on the representative products determined earlier

The debate which follows understandably generates further debate, insights and perspectives leading to additional analyses all of which feed into corporate discussions.

Analyses relate to relevant order-winners and qualifiers as, for example, shown in Figure 3.6 These are further illustrated in Appendix C whichincludes other plant-based applications other than those covered in detail in Chapters 4 and 5. It is important, however, to bear in mind that analyses reflect relevant aspects of the different market segments within a business. As will be illustrated in the next two chapters, manufacturing strategy identifies those priority areas and tasks within production that are most pertinent to current and future customer needs. In no way is it a blanket application to all facets of manufacturing which leads to statements which are apparently strategic in nature but in practice are insignificant in terms of improving overall corporate performance. Typical examples include-

- contribution per machine or labour hour (especially where there is a scarce resource/bottleneck) which allows insights into price sensitivity and the relative weightings attributed to particular representative products
- delivery reliability - measures against agreed lead times
- delivery speed - relating customer lead times to a combination of order backlog/material lead times and process lead times
- capacity reviews in terms of delivery reliability and speed and also relating to stepped changes for products with seasonal sales profiles
- quality - internal and external measures, checking reject rates and customer complaints/returns
- supplier relations in terms of all or some of the points above

In addition to these analyses, there are other manufacturing-related insights which would be checked where relevant and in relation to the performance criteria identified for particular market segments.

In this way, the essential analyses need to reflect the particular features of a segment in terms of the competitive priorities which prevail and the way in which they relate to particular aspects of manufacturing process and infra-structure developments and investments. The outcome is the two-fold debate illustrated by Figures 3.7 and 3.8 and an identification of the key adjustments which need to be made, strategic directions to follow and developments and investments to pursue. Detailed examples are provided in the next two chapters which concern the outcomes of the research and the conceptual developments which resulted.

3.7 DEVELOPMENTS RELATING TO OTHER METHODOLOGIES USED IN THE RESEARCH

As explained earlier and illustrated in Figures 3.2 and 3.3, manufaturing strategy concerns developing process and infrastructure capabilities appropriate to a business. Furthermore, because companies typically compete in several markets then all-embracing investments, though common in practice, are simplistic in concept. The rationale for single solutions, though fundamentally inappropriate in reality, is understandable in origin. Single solutions are less costly in terms of initial investments and are easier to comprehend when explained. The lower cost argument falls in line with traditional economies of scale thinking. Single solution arguments are attractive, in part, by their apparent simplicity and, in part, because they overcome the inherent complexity derived from the need for different manufacturing approaches to be developed which relate to the differences which typically exist in the various markets of a firm. The costs of inappropriateness and lack of fit are rarely gathered. Lost in the day-to-day costs of running a business these sizeable by-products of single solutions go undetected while adding to the complexity of managing the production/operations function and the lack of clarity in identifying the direction of the business overall and the functional strategies in particular. At the operational level the additional on-costs are substantial and at the strategic level, the lost opportunities are immeasurable.

Manufacturing's continued failure to develop an adequate and appropriate understanding of the business and hence arrive at the conceptual base from which it can trace its current position and from which it can build its statements of strategic direction in the future has created a strategic vacuum. As problems arise, companies have had no alternative but to treat symptoms rather than causes. Furthermore, as symptoms are often apparently similar the result has been a solution-driven approach rather than one based on understanding and the particular needs of a business. Panaceas have, therefore, become the order of the day and their use, universal in its application.

3.71 THE USE OF PANACEAS

Examples of panaceas abound. The rise and fall of preferred manufacturing planning and control systems is a recent example. Arguments for Just-in-time developments have replaced the advocates for materials requirements planning with the core arguments implying that one is always the preferred approach in any given situation. Recent collaborative research by the author has attempted to clarify the key differences in manufacturing planning and control systems as they relate to the differing needs of different market segments - see Appendix D.

A further illustration concerns the concept of flexibility. For many businesses, past investments in dedicated procsses have proved inappropriate in terms of current markets. While this has, in part, been brought about by pressures of competition, faced with new investment requirements the response has often been to purchase new equipment with a high level of flexibility. However, where such decisions are not based on an assessment of the marketplace and an evalution of alternatives, then they have degenerated into what is tantamount to a strategic "cop-out". "If in doubt, resolve the doubt" has become, "if in doubt buy flexibility".

The strategic outcomes from this panacea-driven approach are often significant due to the investment trends (even where government grants have, or still do, reduce the capital costs involved), and the time-scales, management attention and energy involved. These substantial disadvantages are further compounded by a corporate belief that the problem has been resolved. However, there are two fundamental issues to be resolved. The first concerns the task of clearly identifying customers' needs and the second is identifying which dimensions of flexibility are relevant (Slack, 1989). Without these, the hallmarks of panacea approaches prevail where companies make relatively large investments which do not fit their market needs or which provide dimensons of flexibility which are not relevant to the business requirement (Hill, 1989, pp83-4).

3.72 THE BUSINESS TRADE-OFFS EMBODIED IN PROCESS CHOICE

The final illustration concerns process choice. Firms invest in processes to make products. Although fundamental differences between processes are recognised, most companies fail to understand the impact on the business of the various options which can be chosen. In addition, academics (Gaither (1980), Tersine (1980), Stevenson (1982), Dilworth (1983), Evans, Anderson, Sweeney and Williams (1984), Schmenner (1984), Schonberger (1985), Adam and Ebert (1986), Buffa and Sarin (1987), Krajewski and Ritzman (1987), Heizer and Render (1988) and Schermerhorn (1980)) have often reinforced the technical rather than business implications of processes by adding further light on the process similarity/dissimilarity in a technical sense whilst failing to add anything which gives insights on the business-related dimension. Creating groups under headings similar to intermittent and flow, machine-paced and worker-paced or product as opposed to process-focused systems illustrate these developments. In addition, hybrid processes such as group technology have been described solely in a technical sense without either the essential context or illustrating the resulting dimensions so critical to their evaluation (Evans, Anderson, Sweeney and Williams (1984), Wild (1984), Schonberger (1985), Adam and Ebert (1986), Krajerski and Rtizman (1987), Heizer and Render (1988), Chase and Aquilano (1989).

My research clearly illustrated the need for a firm to evaluate these major investments in terms of both the technical and business dimensions. Unless processes are chosen for reasons based upon an understanding of the need to meet a business as well as a technical specification (see Figure 3.9) then the essential requirement for a process to meet the needs of the market place rather than just the technical dimensions of a product will neither be recognised nor fulfilled.

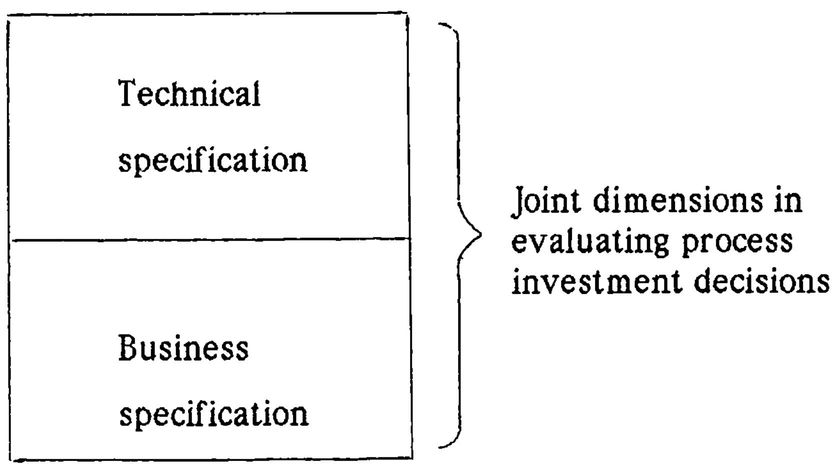

Figure 3.9 The need to develop a business as well as a technical specification to help in the selection of appropriate processes

Just as the technical specification of a product can be translated into a technical specification for a process, the business specification needs a similar translation. While the technical dimensions lend themselves to more precise statements of requirement, the business specification concerns trade-offs.

An early recognition of this was made by Skinner (1969, p139) who highlighted the fact that "what is not always realized is that different marketing strategies and approaches to gaining a competitive advantage place different demands on the manufacturing arm of the company." Thus, as long ago as the late 1960's, Skinner clearly and appropriately identified manufacturing strategy as comprising appropriate support for the particular and different market segments of a business. "The purpose of manufacturing is to serve the company - to meet its needs for survival, profit and growth. Manufacturing is part of the strategic concept that relates a company's strengths and resources to opportunities in the market. Each strategy creates a unique manufacturing task. Manufacturing management's ability to meet that task is the key measure of its success" (Skinner, 1969, p140). In this context, he also developed the notion of trade-offs within manufacturing and listed some of these within the principal decision areas within this function (Skinner, 1969, Exhibit 1, p141).

Whereas, Skinner introduced the concept of trade-offs, it was a Harvard Business School Note first published in 1973 which more clearly recognised the fact that process types have different characteristics to one another across a whole range of dimensions. The differences highlighted and dimensions selected indicated a clear recognition of the business dimension underpinning process investments. These are summarised in Appendix E which also gives an example of the detailed trade-offs involved thereby extending whilst also complementing Skinner's earlier work.

These ideas were also built on by others. Abernathy and Utterback (1975) included the concept of functional differences in their work on evolving structures of the firm. Abernathy provided a fuller treatment of these issues in further publications (Abernathy and Townsend, 1975; Utterback and Abernathy, 1975; Abernathy, 1976 and Abernathy, 1978) which gave more detailed explanations of production process structures and how they related to technical and business changes.

3.73 APPLYING THE CONCEPT OF TRADE-OFFS

There then followed two applications of these concepts which underscored the principles involved on the one hand and extended the conceptual base of manufacturing strategy on the other. The first concerned Skinner's concept of the focused factory. Finding that "non congruent manufacturing structures appear to be common" he posed the question of why "a fully consistent set of manufacturing policies resulting in a congruent system is highly rare". Of the five reasons he gave, the presence and recognition of inconsistencies between manufacturing and the market accounted, at least in part, for four of these. This gave rise to his argument that businesses needed to recognise the strategic requirement to provide manufacturing with a consistent set of tasks thereby highlighting the implications of trade-offs.

The second application was the work of Hayes and Wheelwright (1978) who linked manufacturing process and product life cycles. By extending the principle of trade-offs, they provided a matrix to show how to match the major stages of product and process life cycles (see Figure 3.10). This provided a direct link between the market place and manufacturing processes while illustrating the need to match market needs with the relevant set of trade-offs within manufacturing.

Others have since built on these early contributions. Schmenner (1981) developed the concept of trade-offs still further. On the one hand he attempted to distinguish processes more clearly than Hayes and Wheelwright's job-shop, batch, assembly line and continuous flow. This was illustrated by recognising the difference between machine and worker-paced assembly lines and illustrating other developments such as a batch/ continuous flow hybrid. In addition, he extensively embellished the Harvard Business School Note's on process characteristics as illustrated in Appendix E.

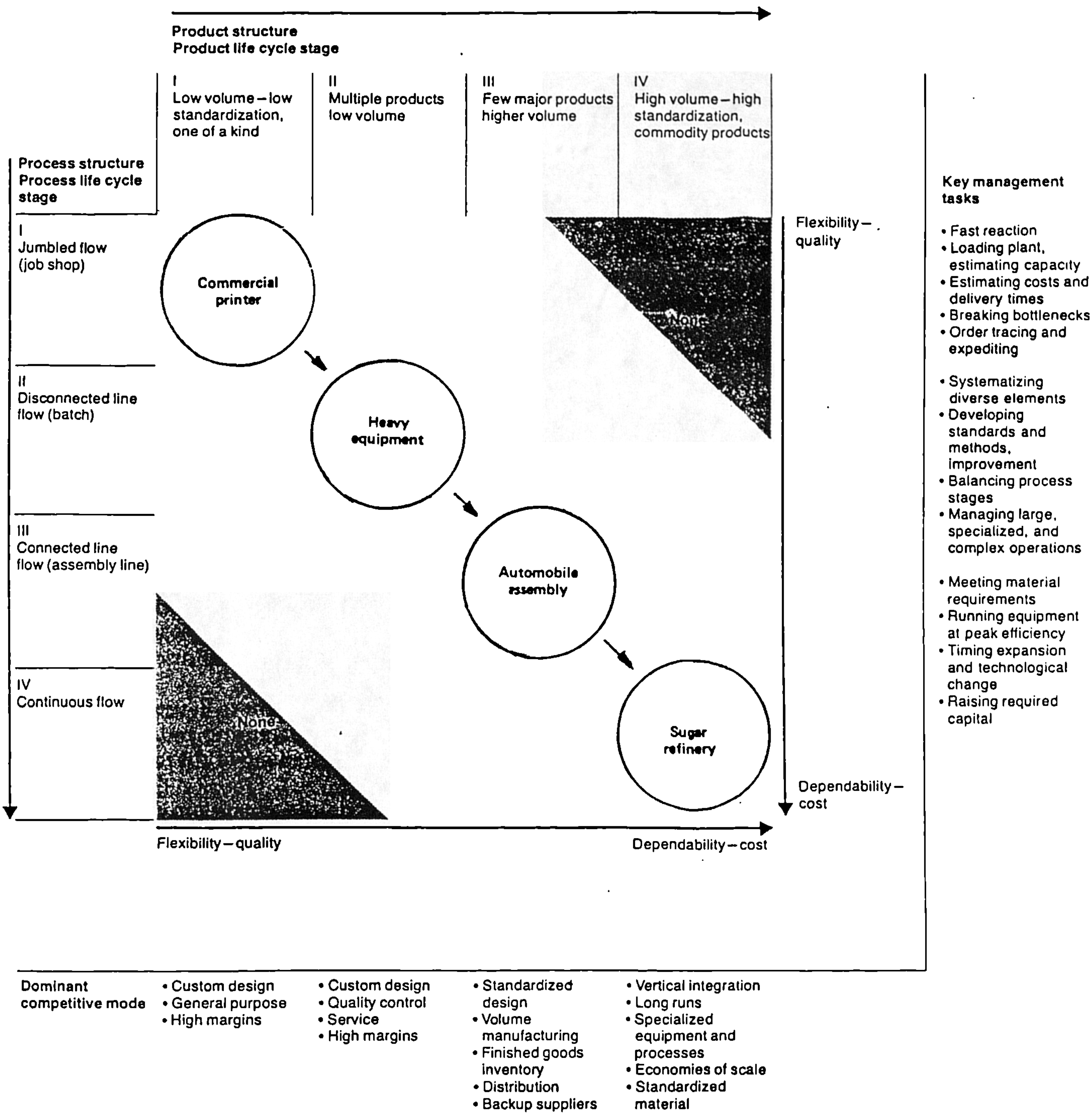

Figure 3.10 A matrix to match product with process life cycles (Hayes and Wheelwright, Exhibits I and II, pp135 and 137)

3.74 DEVELOPMENTS FROM MY RESEARCH

The early stages of my research built on these concepts and led to my own developments within this aspect of methodology. These comprised a two-fold contribution.

The first was a precise definition of processes - just as there are strong and appropriate arguments for precision in determining the manufacturing task within a business, then equally there is a need for a clear understanding of relevant differences between one process and another. In terms of manufacturing and the resulting trade-offs within a business, it became clear that there are five classic types of processes. While there are many hybrids, each will have its root in one of these five. Defined more fully in Appendix F (Hill, 1983, p39, the five processes and their key differences are given below

Project - companies that produce large scale, unique products which are not feasible to move, do so using a project process. As the product cannot be moved, the resources have to be brought to and taken from the site where the product is being made.

Jobbing - where the unique requirements for a customer need to be met but where the product can now be moved, companies normally select the jobbing process. Once the design has been specified, one skilled employee (or if the job is of long duration, possibly a small number of skilled employees) is assigned to the task and is responsible for the planning as well as evaluation of the work on hand.

Batch - with an increase in volume and the repeat nature of a product, batch is typically selected as the appropriate process. With processes laid out by function, manufacturing begins to invest in the process as reducing costs increasingly becomes an important task. To achieve this, product routings are determined, jigs and fixtures made and process investments chosen to reflect the relative increase in volumes.

Line - a further increase in volumes will lead a company to consider line as the appropriate process. Laid out to reflect the sequential steps in making the product or products involved, this and related relevant investments are designed to reduce costs in order to support price as the typical, most important, manufacturing-related order-winner.

Continuous process - with a further increase in volumes, companies producing certain products will select continuous process as the appropriate method of manufacture. In this situation, a basic material is passed through successive stages or operations and refined or processed into one or more products, for example petrochemicals. This process is based upon two features. The first is very high volume demand and the second is that the materials involved lend themselves to be moved easily from one part of the process to another; for example, fluids, gases and foodstuffs.

Furthermore, it also became apparent that batch as a process was used to meet the needs of a very wide range of volumes which were between the "extremes" of an order size of one (or a handful at the most) in jobbing and the very high volumes reflected in line, a factor clearly shown in Figure 3.11. The reality is that when products are repeated then an opportunity to reduce costs through learning curve and process investment gains becomes available. However, for most companies this increase in volumes does not justify going to a line process as the volume involved (quantity x work content) is not of the order to fully utilise a process.

The second contribution from my research concerned the nature of trade-offs. Leading directly from the elongated nature of batch came a recognition that to describe the trade-offs associated with this process as a single statement failed to show the transitional nature of each characteristic as it went from jobbing to line. In order to reflect this, a description under batch was replaced by an arrow. However, although this was an accurate representation in most instances, for some dimensions the transition described earlier did not take place as batch in fact was higher than the other processes with which it was being compared.

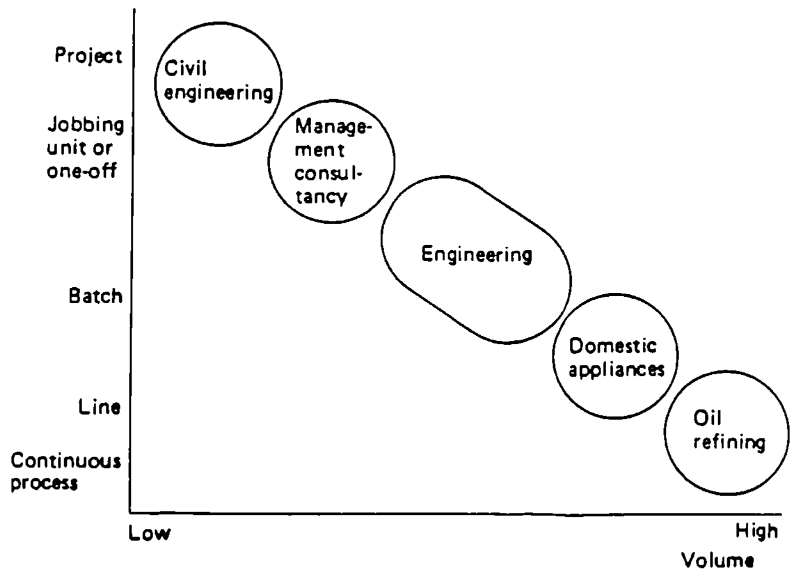

Figure 3.11 Choice of process related to volume (Hill, 1983, p39)

The significance of these issues is not just the clarity brought to a review of manufacturing but also they were to lay the foundations for developing the concept of product profiling, the subject of Chapter 5.

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APPENDIX B

This appendix contains details of the content and issues of manufacturing strategy as put forward by the principal researchers at the beginning of the research period. Appendix B.1 provides a comparison between three major contributors whilst Appendix B.2 reviews Skinner's manufacturing audit approach.

APPENDIX B.1

THE SIMILARITY OF TYPICAL ISSUES AND MANUFACTURING DIMENSIONS WITHIN A MANUFACTURING STRATEGY

Performance criteria

Criteria		Research source: Skinner (1969)	Hayes & Schmenner (Jan 1978)	Wheelwright (Feb 1978)
Price		√	√	√
Quality		√	√	√
Volume	flexibility	√	√	√
Product	flexibility	√	√	√
Dependability	delivery	√	√	√
Dependability	service		√	√

Dimensions of manufacturing strategy

Dimensions		Skinner (1974)	Hayes & Schmenner (Jan 1978)	Wheelwright (Feb 1978)
Plant	size and capacity	√	√	√
Plant	location	√	√	√
Choice of equipment		√	√	
Plant layout/logistics		√	√	
Production process		√	√	√
Production scheduling system		√	√	√
Inventories		√	√	
Wage system		√	√	√
Supervision		√		
Control system		√		
Organisational structure		√	√	
Vertical integration	supplier		√	√
Vertical integration	customer			√
Quality control			√	√

APPENDIX B.2

SKINNER'S MANUFACTURING AUDIT CHECKLIST PROCESS - AN OVERVIEW OF THE KEY ISSUES

1 Make/Buy Choices

- Examine items which could be made or bought
- What does the present make or buy position imply

2 Capacity Decision

- Compared with past, present and forecast demand
- Under/over provision
- Implications of provisioning decision

3 Plant Decisions

- Number
- Size
- Location
- Focus and organisation
- Implication of these decisions

4 Equipment and process technology

- Industry comparison
- Key process review
- Implications and alternatives

5 Production planning and control

- Present systems
- Alternatives
- Implications and alternatives

6 Work-force management

- Selection
- Training
- Pay systems
- Implications and alternatives

APPENDIX B.2

7 Quality control

- Quality levels
- Process design and control
- Training
- Implications and alternatives

8 Manufacturing and industrial engineering and maintenance

- Present systems and choices
- Implications and alternatives

9 Cost and Information Systems

- Present systems and choices
- Implications and alternatives

10 Purchasing

- Present systems
- Vendor selection
- Implications and alternatives

11 Formal organisation

- Present organisation
- Rank order of functions in terms of organisational emphasis
- Performance measurement and evaluation
- Implications and alternatives

APPENDIX C

FURTHER EXAMPLES OF THE ORDER-WINNERS AND QUALIFIERS EMINATING FROM THE RESEARCH TO ILLUSTRATE HOW SEGMENTS DIFFER WITHIN THE MARKETS OF A COMPANY

Appendix C provides a number of examples of the outcome of applying the framework shown as Figures 3.1, 3.2 and 3.3 in the narrative. As also explained in Chapter 3, the examples given here (and also as Figure 3.6) are not those which are discussed in detail in Chapters 4 and 5. The purpose of introducing these examples is to

- illustrate the extensive applications of the framework in the UK and the USA

- reinforce the argument that as market (and segments within markets) differ, so will appropriate manufacturing strategies

- underscore the fact that as a manufacturing strategy concerns supporting a company's markets in a consistent way then the starting point is to understand the nature of these markets in terms of what role manufacturing has to provide in order to help make a company more successful

Notes

1 Where the work was completed as part of a research team (and this is indicated on the examples which follow), the leadership role was always undertaken by myself
2 As throughout the research, the names of the particular companies (where given) have been disguised

APPENDIX C.1

US FURNITURE COMPANY : THE RELEVANT ORDER-WINNERS AND QUALIFERS FOR HIGH VOLUME, MEDIUM VOLUME AND LOW VOLUME OAK FURNITURE FOR THE STRATFORD RAND

	Small Chain			Large Independent			Small Independent			Large Chain		
	1987	1989	1991	1987	1989	1991	1987	1989	1991	1987	1988	1989
Oak Chairs, Case Goods and Tables High Volume												
Quality	50	50	40	50	50	40	60			60	60	60
Price	40	40	50	40	40	50	20			20	30	30
After Sales Service	10	10	10	10	10	10	20			20	10	10
Delivery Reliability	QQ	QQ	QQ	QQ	QQ	QQ	Q			QQ	QQ	QQ
Design	Q	Q	Q	Q	Q	Q	Q			Q	Q	Q
Design changes												
New Products												
Customer Relations	Q	Q	Q	Q	Q	Q				QQ	QQ	QQ
Representative products: A1106, A1126												
Oak Kitchen Medium volume												
Quality	55	50	45	55	50	45	60	55	50			
Price	35	40	45	35	40	45	20	30	40			
After Sales Service	10	10	10	10	10	10	20	15	10			
Delivery Reliability	QQ	QQ	QQ	QQ	QQ	QQ	Q	Q	Q			
Design	Q	Q	Q	Q	Q	Q	Q	QQ	QQ			
Design changes												
New Products												
Customer Relations	Q	QQ	QQ	Q	QQ	QQ		Q	QQ			
Representative product: A1085												
Oak Kitchen/ Dining Room Low volume												
Quality	60	60	60	60	60	60	60	60	60			
Price	Q	Q	Q	Q	Q	Q	Q	Q	Q			
After Sales Service	10	10	10	10	10	10	10	10	10			
Delivery Reliability	Q	Q	Q	Q	Q	Q	Q	Q	Q			
Design	30	30	30	30	30	30	30	30	30			
Design changes												
New Products												
Customer Relations	Q	Q	Q	Q	Q	Q						
Representative products. A1145, A1073												

Notes 1 Q denotes a qualifier
2 QQ denotes an order-losing sensitive qualifier
3 The large chain did not purchase these medium or low volume items
4 Joint research undertaking

APPENDIX C.2

EUROPEAN BATTERY COMPANY : ORDER-WINNERS AND QUALIFIERS FOR SELECTED MARKETS

Product Type A10

	1986	1991	1993
Design	10	20	40
Quality	20	20	-
Delivery - speed	70	40	30
- reliability	Q	QQ	QQ
Price	Q	20	30

Representative products A10 - 60, 82 and 110

Product Type B40

Quality	20	30	10
Delivery - speed	20	20	20
- reliability	QQ	QQ	QQ
Price	50	50	70
Technical field support	10	-	-

Representative products B40/6

Product Type B500

Design	50	50	50
Quality	40	40	30
Delivery - speed	10	10	20
- reliability	QQ	QQ	QQ
Price	Q	Q	Q

APPENDIX C.3

UK FOOD PRODUCER : ORDER-WINNERS AND QUALIFIERS FOR SELECTED PRODUCTS

Product - Beverage (A)

	1988	1991
Brand - image	50	60
- support	QQ	QQ
Product range	10	10
Packaging	10	-
Design	30	30
Price	QQ	QQ
Quality	QQ	QQ
Delivery - speed	QQ	QQ
- reliability	QQ	QQ

Product - Food (B)

	1988	1991
Brand - image	35	30
- support	5	5
Product performance	20	20
Price	40	45
Quality	Q	Q
Delivery - speed	Q	QQ
- reliability	QQ	QQ

Product - Food (C)

	1988	1991
Brand - image	20	30
- support	5	10
Consumer packaging	Q	Q
Product performance	35	35
Price	40	25
Quality	Q	Q
Delivery - speed	Q	Q
- reliability	Q	Q

APPENDIX C.4

NORTH AMERICAN PACKAGING COMPANY : ORDER WINNERS AND QUALIFERES FOR SELECTED MARKETS

Representative Products	*Year*	*Price*	*Design Support*	*Technical Competence*	*Delivery Speed*	*Delivery Reliability*	*Quality*	*Sales Support*	*Nationally Based Marketing*
				Market A					
6	87	30	40	—	—	Q	20	—	10
	88	40	20	—	—	Q	10	20	10
	89	70	—	—	—	Q	10	20	—
12	87	70	—	—	10	Q	Q	20	—
	88	50	—	—	20	Q	Q	30	—
	89	50	—	—	20	Q	Q	30	—
3 and 4	87	90	—	—	—	10	Q	—	—
	88	90	—	—	—	10	Q	—	—
	89	90	—	—	—	10	Q	—	—
				Market B					
10	87	40	—	Q	40	QQ	Q	—	20
	88	40	—	Q	40	QQ	Q	10	10
	89	60	—	—	30	QQ	Q	10	—
23 and 25	87	60	—	—	20	10	10	—	—
	88	65	—	—	15	10	10	—	—
	89	75	—	—	10	5	10	—	—

Note: Q denotes a qualifier and QQ, an order-losing sensitive qualifier.

APPENDIX D

MANUFACTURING STRATEGY, PROCESS CHOICE AND MANUFACTURING PLANNING AND CONTROL SYSTEMS

The framework developed as Figures 3.1 to 3.3 emphasises the need to link the characteristics of markets to the investments in manufacturing. The argument developed in Section 3.6 of the thesis narrative is that this essential linkage characteristically fails to be established. The result is that companies typically invest in solutions, the stimulus for which is the solution itself rather than the business requirement which the particular investment is intended to provide. One such area where this occurs is that of manufacturing planning and control systems.

Collaborative research* has led to establishing a conceptual link between manufacturing strategy, process choice and appropriate manufacturing planning and control systems. An illustration of the results of this work is provided as Appendix D.1.

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* Undertaken with Professor W L Berry, School of Business, University of North Carolina at Chapel Hill

APPENDIX D.1

Company	Market Characteristics	Order Winners And Qualifiers	Manufacturing Strategy: Manufacturing – Task	Manufacturing Strategy: Manufacturing – Features	Manufacturing Planning and Control System – Master Production Scheduling	Manufacturing Planning and Control System – Material Planning	Manufacturing Planning and Control System – Shop Floor Control
A	• Customized products • Wide product range • Low volume per product • Make-to-order • Initial vs repeat orders • Future order call-offs	• Design capability • Delivery speed • Delivery Reliability – Q, Q • Quality – Q • Price – Q	• Reducing Process Lead Time • To manufacture to engineering specifications and quality standards • Delivery reliability is critical	• Batch manufacturing • Long process routings • High precision work • Accomodate delivery and design changes with reliable deliveries • Labor cost equals 60% • Control of actual costs against budget • Scrap & rework order priorities + first orders + normal scrap allowance • First order processing uncertainties (process) unknown, time estimates) • Process and Product Uncertainties	• Make-to-order/ assemble-to-order + Customer orders + Anticipated orders + Forecast orders • Used for rough cut capacity planning due to long lead time impact on delivery • Customer order promising	• Time phased material planning • Material is particular to customer orders • High obsolescence risk • Extra materials needed for scrapped items • Trade-off: shorter lead time vs raw material inventory	• Push system • Priority scheduling of shop orders • System supported by dispatching and production controller personnel • Capacity requirements planning by work center • Order tracking and status information
B	• Narrow product range • Standard products • High volume per product • Seasonal demand • Sales from finished goods inventory at distributors • Introduction of new products • Changing product mix	• Price • Delivery speed (through finished goods inventory in distribution divisions) • Quality — Q • Delivery Reliability — Q • Basic Design and — Q Peripheral Design Changes	• To provide a low cost manufacturing support capability • To support the marketing activity with high delivery speed through finished goods inventory	• High volume batch and line production process • Short set-up times Small batch sizes • Low cost manufacturing • Low labor cost • High material cost • Inventory reduction (raw material, components and WIP) • Overhead reduction (low MPC costs)	• Make-to-stock • Manufacture to forecast • Level production • Three month frozen planning horizon • Manufacture to replenish distribution inventories	• Rate-based material planning	• Pull system • Kanban containers • JIT flow of material • Low raw material, component, and WIP inventory

Note: Q denotes a qualifier, ie a capability required in order for the company to enter and remain in its market

QQ denotes an order-losing sensitive qualifier, ie a capability which if not supported leads to a rapid loss of business

APPENDIX E

TYPICAL CHARACTERISTICS OF PROCESSES : OVERVIEW AND DEVELOPMENTS

As explained in the thesis narrative, when companies invest in processes they also invest (knowingly or not) in a set of business-related trade-offs. The recognition of this was first formally made in a Harvard Business School Note and built on by others including Schmenner (1984) and myself. The characteristics reviewed in the former reference are given here as Appendix E.1 and those of Schmenner as Appendix E.2. The developments I made are reviewed as part of Chapter 5 to which the characteristics of process issues relate.

APPENDIX E.1

AN OVERVIEW OF THE HARVARD BUSINESS SCHOOL NOTE ON PROCESSES

Characteristics reviewed		
Suit-ability to	type of product	volume product change demand variation market type
	method of production	task characteristics capital embodied technology
Human inputs suitability		labour skills work environment labour characteristics
Material inputs		raw material inventories
Production characteristics		material handling in-process inventories productivity production control capacity control throughput times (manufacturing cycles)

Table 1 of HBS Note 9-674-023 also gives an explantion of how each of the above characteristics differed depending on the process involved. The first few dimensions above are given on the next page as an illustration but other details have not been included. However, it can clearly be seen from these descriptions that the business-related nature of these characteristics is at the heart of the analysis. The other descriptions contained in the HBS Note are similar in nature, reinforcing this perspective

APPENDIX E.1

SUITABILITY TO TYPE OF PRODUCT	LINE	JOB SHOP	PROJECT/UNIT
Volume	Suited for high volume stand-ardized product	Suited for product line that has low volumes of identical products and considerable variety in product characteristics	Suited to large high-cost products with little stand-ardization and low volume
Product change	Change is costly since entire process must be changed or balanced with product change	Product changes are easily accommodated	Well suited to continuous change - uniqueproducts
Demand variation	Best suited to stable demand without heavy cyclicality	Lumpy or uncertain product demand	Wide variation in product demands are accommodated with labour variations
Market type	Standardized mass marketed product usually produced for inventory	Production is usually to order	Production to customer specification or design

APPENDIX E.2

CHARACTERISTICS HIGHLIGHTED BY SCHMENNER WHEN COMPARING PROCESSES OF DIFFERENT TYPES

Features reviewed

Product
- mix
- compete largely on
- unlikely to compete on
- introductions

Process
- pattern
- linking to process segments
- type of equipment
- balance of equipment
- capital utilization
- typical size of operation
- economies of scale
- yields
- notion of capacity
- additions to capacity
- speed of process
- pacing
- bottleneck
- nature of process change
- place of technoligical change in process
- set-ups
- run lengths

Management
- staff-line needs
- degree of corporate influence
- means of control
- challenges

Materials
- requirements
- character of
- vertical integration
- inventories
  - raw materials
  - work-in-progress
  - finished goods
- control over suppliers
- control over customers
- supplier ties
- customer ties

Information
- order handling and sales
- degree of information coordination
- systems within factory
- trigger for production
- scheduling
- quality control
- response to cyclicality of demand

Labour
- content percent
- job content
- importance of labour standards
- worker - payment
  - advancement
- end of month syndrome

APPENDIX F

DEFINITIONS OF THE FIVE CLASSIC PROCESSES

Below are definitions of five classic processes. In many written statements there is a failure to clarify these essential differences in themselves and a tendency to list processes (which are, in fact, hybrids of these classic options) as separate processes rather than as derivations of these classic forms. For, without this clear understanding of the root stock on which a hybrid is based, then the recognition of trade-off changes will not be appreciated or highlighted.

Project. Companies that produce large-scale, one-off, complex products will normally provide these on a project basis. Examples include civil engineering contracts and aerospace programmes. It concerns the provision of a unique product requiring large-scale inputs to be coordinated, so as to achieve a customer's requirement. The resource inputs will normally be taken to the point where the product is to be built, since it is not feasible to move it once completed. All activities, including necessary support functions, will usually be controlled in the form of a total system for the duration of the project. Resources will be allocated to the project and reallocated once their part of the task is complete, or at the end of the project.

The selection of project as the appropriate process is based upon two features. The product is a one-off, customer-specified requirement and, secondly, it is often too large to be moved, or simply cannot be moved once completed. The latter criterion is such an overwhelming facet of this decision that products of this nature will always be made using the project choice of process. However, businesses will also be concerned with determining how much of the product to make away from site and how best to provide the parts or sections that go into the structures made on site. These will, in turn, be produced using a different choice of process than project. These decisions need to be based upon other criteria, which will become clear in the descriptions of other choices that follow.

Jobbing, Unit or One-Off. Job shops meet the one-off (ie unique) order requirements of customers; for example, purpose-built tooling. The product involved will be of an individual nature and requires that the supplier interpret the customer's design and specification, while applying relatively high level skills in the conversion process. A large degree of this interpretation will normally be in the hands of the skilled employee, whose experience in this type of work will be an essential facet of the process. A key difference with regard to project is that the product can now be moved.

In jobbing, once the design has been specified, one or possibly a small number of skilled employees (if the job is time consuming) are assigned the task, and are responsible for deciding how best to complete and carry it out. This may also include responsibility for scheduling, liaison with other functions, and some involvement with arrangements for outside, subcontracted phases, where necessary.

This one-off provision means that the product will not again be required in its exact form or, if it is, the demand will tend to be irregular, with long time periods between one order and the next. For this reason, therefore, investment in the manufacturing process (eg in jigs, fixtures, and specialist plant) will not normally be warranted.

Batch. When a company decides to manufacture using batch processes, it does so because it is providing similar items on a repeat basis, usually in larger volumes (quantity x work content) than associated with jobbing. However, companies do manufacture order quantities of one on a batch basis. In this instance, what underlies their decision as to which process to adopt is the repeat nature of a product, not the size of an order quantity. Batch process is chosen to cover a wide range of volumes, as represented in Figure 3.12, by the elongated shape of batch, compared to the other processes. At the low volume end, the repeat orders will be small and infrequent. In fact, some companies producing very large, one-off items will adopt a batch, rather than a jobbing process approach, to their manufacturing. When this happens, the work content involved will be high in jobbing terms, and often the order quantity is for a small number of the same but unique items. At the high-volume end, the order quantities may involve many hours, shifts, or even weeks of work for the same product at one or more stages in its designated manufacturing route.

The procedure followed in batch is to divide the manufacturing task into a series of appropriate operations, which together will make the products involved. The reason is simply to determine the most effective manufacturing route, so that the low cost requirements of repeat, higher volume markets can best be achieved. At this stage, suitable jigs and fixtures will be identified in order to help reduce the set-up and processing times involved, the investment in which is justified by the total product output over time.

Each order quantity is manufactured by setting up that step of the process necessary to complete the first operation for a particular product. The whole order quantity is now completed at this stage. Then, the next operation in the process is made ready, the total order quantity is completed, and so on, until all the stages required to make a product are completed. Meanwhile, the process used to complete the first operation for the product is then reset to complete an operation for this or another product, and so on. Thus, capacity at each stage in the process is used and reused to meet the different requirements of different orders.

Examples include moulding processes where one mould to produce an item is put into a machine. The order for that component or product is then produced, the mould is taken off, the raw materials may have to be changed, and a mould for another product is put into the machine, and so on.

Similarly, in metal maching processes, a machine is set to complete the necessary metal cutting operation for a product, and the whole order quantity is processed. When finished, the machine in question is reset to do the required metal cutting work on another item, while the order quantity of the first product goes on to its next stage, which is completed in another part of the process. At times, an order quantity may have more than one stage completed on the same machine. Here the same principle applies, with the process reset to perform the next operation through which the whole order quantity will be passed.

Line. With further increases in volumes (quantity x work content), investment is made to provide a process that is dedicated to the needs of a single or normally small range of products. The width of the product range will be determined at the time of the investment. In a line process, products are passed through the same sequence of operations. The standard nature of the products allows for this and, hence changes outside the prescribed range of options (which can be very wide, for example, with motor vehicles) cannot be accommodated on the line itself. It is the cumulative volume of the product range that underpins the investment.

As explained in a later section, it is important to clearly recognize the fundamental differences in terms of what constitutes "volume". In a car assembly plant, for instance, customer order quantities are normally small. The eventual owner of a car orders in units of one, which the dealership passes onto the assembly plant as an order for a single car, or cumulates with one or more other orders for single units. In manufacturing terms, however, all orders for single cars are for products that the production process interprets as being the same product. Hence, the order quantity of a car assembly plant comprises the cumulative volume of all orders over a given period. It is this perspective that constitutes the high-volume nature of this business, and the choice of line as the appropriate process.

The wider the product range, then normally the higher is the investment required in the process in order to provide the degree of flexibility necessary to make these products. Where the options provided are very wide, and the products involved of high cost or of a bulky nature, then the more likely is the company to make these on an order basis only. For example, there will normally be a longer delay when purchasing a motor vehicle (especially if several options are specified) than say a domestic appliance. The underlying reason for this is the different degree of product standardization involved. The motor vehicle will be made against a specific customer order, and the domestic appliance to stock.

APPENDIX F

Continuous Process. With continuous process, a basic material is passed through successive stages or operations, and refined or processed into one or more products; for example, petrochemicals. This choice of process is based upon two features. The first is very high volume demand, and the second is that the materials involved lend themselves to be moved easily from one part of the process to another; for example, fluids, gases and foods.

The high-volume nature of the demand justifies the very high investment involved. The processes are designed to run all day and every day with minimum shutdowns, due to the high costs of starting up and closing down.

Normally, the product range is quite narrow, and often the products offered are purposely restricted, in order to enhance volumes within the other products in the range. For example, UK oil refining companies do not offer either one or five star petrol, with three star petrol no longer available on all petrol station forecourts. In this way, companies have restricted the range of octanes and increased the volumes associated with the grades that are provided.

In continuous process, the other feature is the nature of the materials being processed. Whereas in line there are manual inputs into the manufacture of the products as they passed along, in continuous process the materials will be transferred automatically from one part of the process to the next, with the process monitoring and self-adjusting flow and quality. The labour tasks in these situations are predominantly involved in checking the system.

Source: Hill (1989) pp55-8

4 DEVELOPING A MANUFACTURING STRATEGY

As explained in the 'Literature Review' (Chapter 2) one difficulty I faced was how to present the available literature given the time span over which the research had been undertaken. In order to provide an overview of the work completed by others at the start and the areas of further research which as a consequence, needed to be investigated in the future then a literature review split was made to reflect this dual requirement. Chapter 2, therefore, concentrated on the outcomes at the beginning of this research. What follows as the first section of this chapter is a review of the work on manufacturing strategy completed by others during the period of my research. Its purpose is to provide the necessary background against which my findings need to be placed.

4.1 STATEMENTS THAT THERE WAS A PROBLEM

Throughout the 1980s a growing voice continuously reinforced the message that there was a manufacturing problem. Whilst many contributors used this as part of their opening remarks some validly chose this as their main statement or as part of a general statement on manufacturing businesses. Furthermore, the source of statements continued to be widespread - Skinner (1980), Foster (1981) and Shapiro (1987) in the US, and Foster (1980) and Pendlebury (1987) in the UK. The more subtantial of these statements are referenced in the following sections and further illustrate the extent and growing sources of commentary.

4.2 STATING THE NEED FOR A STRATEGIC APPROACH IN MANUFACTURING

Linked to the last section, there was an increasing number of statements recognising the key need for approaching the resolution of improving overall performance, in part, through developing a manufacturing strategy. However, the underlying contribution of these statements was held as the statement of approach and not what form the approach should take.

Henzler (1982) highlights the way in which functional approaches (including manufacturing) inhibit the formulation of strategy and emphasises the need to review the role of production within the business context. Mehl (1983) quotes John Madden, then coach to the Oakland Raiders, of the need for businesses to recognises the principle of "the whole, the part and the whole" and in particular the need to determine the business in which a company operates and then develop a production function to support these requirements. Ferdows, Miller, Nakane and Vollman (1986) in this and many related statements based upon their continuing Globlak Manufacturing Futures Survey work commenced in 1983, together with Hayes and Jaikumar (1988) also gave strong support for this facet of the research. In addition, several others contributed to the growing tenor for developing a manufacturing strategy statement thus adding to the general swell of argument which characterised the 1980s (Judson, 1984; Swamidass, 1985; Hayes, 1985 and Business Week, 1986).

4.3 METHODOLOGY-ORIENTATED CONTRIBUTIONS

Research has different sets of objectives and consequently the output of that research will reflect the particular emphasis undertaken. The more general statements of need covered in the last two sections either had this issue as a central theme or as a part of some other, large statement. As would be expected, the extent to which a statement detailed the methodologies being used within the field would similarly differ. To help identify some of these key differences this section has been split into four sub-sections reflecting different types of methodology developments.

4.31 GENERAL STATEMENTS

Building on from the last two sections, other contributors in this period enlarged on the "need for a strategic approach in manufacturing" (Section 4.2) towards a general statement on methodology. These offered different levels of detail but in all instances had a methodology orientation in varying degrees.

Typical of these levels of development is the work of Schmenner (1982), Booz-Allen Hamilton (1984), Richardson et al (1985), Blois (1986) and Montgomery and Hausman (1986). Schmenner's work identifies four distinct multiplant manufacturing strategies in terms of product, market area, process and general-purpose plants and orientates the reader towards identifying the roles of plants and the need to assess their appropriateness in terms of the markets they serve. Booz-Allen and Hamilton (1984, p4) outline a general approach to the development of a manufacturing mission and argue that the fundamental task of this statement is to help resolve the key issues of plant size, plant focus, level of response capability to meet the changing needs of a market and the location of a plant. The paper later illustrates general perspectives regarding product/market segmentation and provides insights into a number of different issues. Building on the work of others, Richardson et al identify the relevant strategic alternatives as those between cost, quality, volume, delivery and design and then link choices to an evaluation of manufacturing performance. Based on this research they fit the identified "manufacturing task profiles" as being new product centre, custom innovator, cost-minimising job shop and cost minimiser. Having previously identified six different corporate missions they argue that the strategic task is to link these profiles to the relevant corporate mission.

Blois (1986) continues the identification of general statements of methodology encompassed in linking flexible manufacturing systems (FMS) to marketing by listing the classic areas of conflict between the two functions and uses FMS capabilities to highlight ways of overcoming them. Just as the latter contribution was provided by researchers with a marketing base, the final, specific contribution concerns a mix of marketing and manufacturing researchers. These later contributions were, to some extent, an outcome of developments in manufacturing strategy in that for the first time they offered a way of interfacing researchers from both areas of study. Identifying the market from a similar base provides a common set of interests and a way of resolving differences. Montgomery and Hausman specifically identify interfaces. Rank ordering typical manufacturing objectives relating to cost, quality, reliability, dependability and flexibility becomes their basis for strategy development. Their article then selects issues and illustrates the benefits to be derived from this strategic coordination.

In addition to the more specific contributions within the section, others, including Bouldon (1981), Fieldman (1988) and Schmenner (1988), also provide general statements relating to strategic development within manufacturing and its role and importance within a business.

4.32 PANACEA-RELATED APPROACHES

Other contributors within the field argued for particular approaches as being universally applicable or adaptable to meet the needs of businesses in general. Within this theme, one of the principal arguments was for the use of approaches developed and used with great success by Japanese companies. Calling for just-in-time, quality circles, total quality management-type approaches to be used these contributors argued that these approaches were the essence of a suitable, general manufacturing strategy. Cole (1980), Bolwijn and Brinkman (1987) and Boer and Krabbendam (1987) all advocated these directions as the appropriate strategic response from manufacturing. Others (Parnaby, 1979, 1985, 1986 and Ferdows and Lindberg, 1986) also included Japanese approaches as part of their strategic argument. The final contribution in this theme is the Institution of Production Engineer's book (1986) on manufacturing strategy. Although later I will argue against panacea related approaches in general, this latter contribution was an extreme example of the low level of value which solution-orientated approaches offer. Comprising a number of superficial statements, it put forward a mixed bag of approaches in an uncoordinated and incoherent way arguing that these were appropriate examples of manufacturing strategy formulation.

4.33 STATEMENTS REINFORCING EXISTING APPROACHES

Several contributors provided support for the pre-1980 developments detailed in Chapter 2. Some (such as Hayes, 1981; Wheelwright, 1981; Hayes and Wheelwright, 1985 and Skinner 1985 and 1986) were important reinforcements of their earlier work. The back-to-back articles by Hayes (1981) and Wheelwright (1981) underlined the deep-seated understanding of strategy formulation within many successful Japanese companies and the fact that they paid "a good deal more than lip service to the goal of making operations and strategy mutually supportive" (Wheelwright, 1981, p69). However, and more so in the case of Wheelwright, the opportunity was used to reinforce the approach to manufacturing strategy they provided earlier. In 1984 they jointly authored a major book in this field. A mix of production/operations management and manufacturing strategy, this contribution drew together and built on their earlier work.

Although as implied by the last statement, their book is a major and important statement in the field of production/operations management and manufacturing strategy, this section sets to one side aspects within strategy which do not relate to methodology issues (for example, long-term capacity strategies, focus, vertical integration and sourcing and managing changes in manufacturing's technology and structure, the subject of Chapters 3, 4, 5, 9 and 10 respectively of Hayes and Wheelwright (1984). As mentioned earlier, the substance of the methdology put forward by them was drawn from their earlier work. Their additions included a recognition of the need to highlight importance but their approach still failed to provide a way for an organisation to gain the level of clarity and insight to enable it to recognise and build differences. As shown in Appendix G.1 their suggested approach reviewed all eight differences of manufacturing strategy for each business. It recognised the need to develop a strategy to reflect each business but the mechanism of symbols offers too bland an approach for these critical differences to be identified. Whilst they recognised the need for different manufacturing strategies for different businesses, they still perceived the relevant dimensions of a strategy to be the same for all businesses and failed to provide within their proposed approach a way of clearly separating the relative importance of each dimension within a company.

Their other notable contribution to methodology concerned identifying four stages of development in manufacturing's strategic role. Shown in more detail as Appendix G.2 they outline the stages as

- Stage 1 - minimise manufacturing's negative potential:
  "Internally neutral"

- Stage 2 - achieve parity (neutrality) with competitors:
  "Externally neutral"

- Stage 3 - provide credible support to the business strategy:
  "Internally supportive"

- Stage 4 - pursue a manufacturing-based competitive advantage:
  "Externally supportive"

As shown in the Appendix, these headings are supported by additional statements which give further detail.

Although this perspective offers a useful summary of the stages involved, its contribution is one of a general statement of outcome rather than a specific statement of process.

At about the same time, Skinner (1985) also published a book within this field. It was a publication, however, which summarised his position as can be seen by the fact that of the twenty chapters, fifteen were reproductions of previously published work. However, of the new contributions, two concern methodology. Whereas one (Chapter 8) largely restates existing work, the other (Chapter 7) clearly identifies the need for manufacturing strategy to be recognised as "an effective, pervasive philosophy of manufacturing." (Skinner, 1985, p85). To illustrate, he argues that

1 Corporate strategy, marketing, industry technology or industry economics are not fully studied, thought-through, and incorporated into the thinking of the manuacturing team and the task statement.

2 Statements of a manufacturing task fail to go beyond a ranking of criteria for judging manufacturing performance into a set of priorities. For example, "the highest priority is reduced lead times; second is cost; third is quality..."

3 The manufacturing task is excessively general - it does not include specific objectives or standards and does not identify which of these are going to be the most difficult to attain.

4 The manufacturing task does not clearly state its implications and its disclaimers (eg what we will not do). (Skinner, 1985, p86)

From his research he also identified the stages in the development of a statement of manufacturing task as

- Stage 1 - a collection of goals
- Stage 2 - goals with priorities
- Stage 3 - "musts" with priorities related to the corporation's cricitcal strategic needs for successfully competing in its industry and financing its growth
- Stage 4 - the "name of the game" is made explicit
- Stage 5 - the manufacturing task statement (Skinner, 1985, pp88-92)

What Skinner does, therefore, is stress the outcomes of an appropriate manufacturing approach and in doing so underlines some of the specific issues which must be addressed.

In addition, there were several contributions which primarily reinforced the methodologies put forward by Skinner, Hayes and Wheelwright. Kamran (1981) reinforced the general issues involved and stressed the need to develop a manufacturing mission from an understanding of the market. He outlines a "strategic manufacturing process" (Kansan, 1981, p35) but provides no detail on how to complete this. Stobaugh and Telesio (1983) stressed the need to identify the market giving the general dimensions of cost, product flexibility, volume flexibility, product performance and product consistency as the means of explaining the manufacturing task. These, together with explanations of linkage between product strategies and manufacturing related to and reinforced earlier statements. Similar reinforcement was also provided by Gudnasson and Riis (1984) and Chase (1987) which gave a checklist of a number of approaches.

4.34 METHODOLOGY DEVELOPMENTS

Although statements confirming the fact that manufacturing's strategic contribution was low, those re-stating the need for a strategic approach in manufacturing and those reinforcing existing approaches to manufacturing strategy development were important contributions to the area, the conceptual base of the field of manufacturing strategy was still far from adequate. In particular, the methodology for developing a manufacturing strategy had not progressed much further than the early work of Skinner, Hayes and Wheelwright. Although several of the already-quoted researchers had added to the aspect of approach, their contributions were usually in the form of observations or comments.

However, there were some developments which took the methodology a stage further. In all instances they did not progress the basic concepts themselves but did provide the important dimensions of clarity and identity.

The first of these was Mayer and Moore (1983) whose paper introduced two important dimensions in the development of manufacturing strategies appropriate to business needs*

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*These, in fact, were part of the work of Booz-Allen and Hamilton, a management consultancy firm and are also available from other sources

1 The clear recognition that a company's markets were different, a fact which should always be developed

2 That not only do the relevant "competitive success requirements" need to be identified for each segment but the importance of each had also to be assessed. Their work scored these differences as 'dominant', 'next in importance' and 'least important'.

The other contributors were Cohen and Lee (1985) and Fine and Hax (1985). Both stressed the need to link the particular dimensions of the market to the relevant elements of manufacturing. The former built quite clearly on the work of Skinner, Hayes and Wheelwright. Identifying the "operationally significant performance measures" as related to "cost, quality, service and flexibility" they recognised the need to link these to the five important areas of product, process, facilities, control and organisation and within those identified twenty-two relevant decision areas (Cohen and Lee, 1985, pp156-7). This is supported by their "manufacturing strategy paradigm" which required that first, a company's market segments are to be separated, then an assessment of these is to be made in terms of their "operationally significant performance measure" and finally these are to be linked through to investments in the relevant decision areas referred to above. The work is, however, theoretical in use but the linkage arguments are clear, providing a detailed methodology statement.

Fine and Hax (1985) also clearly stressed the important feature of integration within the development of a manufacturing strategy. This they recognised as being between the major functions within a business and the need to link manufacturing strategy to business strategy (Fine and Hax, 1985, pp31 and 57 respectively. They also (as with Mayer and Moore) highlighted the need to differentiate between the relative importance of the "external performance measures" of "cost, quality, delivery and flexibility". This should be achieved by weighting out of one hundred points which needed to be supplemented by a "subjective assessment ... of the competitive performance of each product and its most relevant competitors in each of the performance criteria". The four categories ranged from 'very high weakness' to 'very high strength'. (Fine and Hax, 1985, p39)

4.4 RESEARCH CONTRIBUTIONS TO THE METHODOLOGY FOR DEVELOPING A MANUFACTURING STRATEGY

In Chapter 3 the methodology outcomes of my research were reviewed. Before illustrating applications of this approach, it would seem appropriate to briefly summarise the key perspectives which my research contributed in terms of the methodology for developing a manufacturing strategy

- Most businesses are different
- It follows, therefore, that manufacturing strategies must reflect these differences
- As process and infrastructure investments are to be made to support the needs of a market, then a clear understanding of the dimensions of each market needs to be established
- As most businesses are different, then the way in which orders are won will be different. This will involve different order-winners on the one hand and greater emphasis of a particular criterion on the other
- As the key is distinguishing market differences, then all ways of helping to achieve this need to form part of the methodology
- Proposing similar dimensions for all businesses, therefore, will blurr rather than clarify this important facet of the procedure
- Qualifiers, order-losing sensitive qualifiers and weighted order winners (including non-manufacturing related criteria) are an

important step in achieving adequate clarity on which to base a manufacturing strategy and subsequent investments

4.5 OVERVIEW OF APPLICATIONS RE METHODOLOGY AND OTHER MANUFACTURING STRATEGY RESEARCH ISSUES IN THE PERIOD 1979-1989

During the period of the research I undertook thirty-three plant-based applications relating to the field of manufacturing strategy. Appendix H.1 gives details of these while Appendix H.2 summarises them by year and the principal type of application.

A review of these shows that several aspects within this field of research were addressed by this range of applications. At the time of writing-up the research findings, two questions needed to be resolved. Which aspects to include and which applications to use as the basis for illustrating the research findings involved.

The decision reached on which aspects to include was based upon the level of contribution to the particular facet of the area and its perceived importance. With this in mind I chose the developments in manufacturing strategy methodology and product profiling. The first was selected because I consider it to be fundamental to the area itself. The second was selected because of its level of contribution to new knowledge.

Having made this initial decision then the issue of how best to illustrate these aspects needed to be addressed. For product profiling the number of appropriate applications limited the choice for me. In the case of methodology developments I selected the first application I undertook (HQ Injection Moulding) and one completed in 1986 which followed the developments I made by that time and was also a clear example of both methodology development and segmentation.

It is opportune to make a final comment about the plant-based applications and their obvious anonymity. Many companies are more willing to allow the plant-based research to be written up in one of various forms providing that the actual company name is not used. This, together with the fact that a plant's financial and other commercial data is not generally made available (accounts are published in a consolidated form) then they do not feel as though the issues can be traced to their origins. For the companies involved, therefore, any commercial sensitivity is removed while for the researcher the issues and substantiating data are not restricted. On the contrary, a company is more willing to provide access to key data under these arrangements.

4.6 DEVELOPING A MANUFACTURING STRATEGY : HQ INJECTION MOULDING COMPANY*

The final sections of this chapter relate to applications to two different companies of the framework which I have developed. They illustrate the essential insights which companies require in order to evaluate strategic alternatives from a manufacturing as well as a marketing perspective. Only then is a company able to evaluate which of the strategic directions is best for the company as a whole.

HQ Injection Moulding had been a major components supplier to the domestic appliance industry prior to its acquisition in 1966 by one of its customers. At the time, it had its own range of homeware products and supplied components to other industries. By the early 1970s, the parent Group accounted for over 50% of existing capacity (Appendix I.1 shows the make-up of machine sizes in 1972 and 1979, the year immediately before the research in this company commenced). About 1972, the Group was re-structured and notice was given that the Group requirements on the company

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*The Company name has been disguised

would be phased out over the following two years.

This was not the only problem. The company's homeware range also faced competition from small firms who were able to compete effectively in this sector of the market.

The consumer saw the company's homeware products as plastic first and homeware second". "The traditional image of plastic as a cheap and transient material dominated, and HQ competed in the market place on price. Thus, faced with the loss of 50% of its sales revenue, the company had three strategic options

1 To downsize to some 50 percent of its current size
2 To attempt to grow the sales of its current homeware products to make up the shortfall
3 To introduce a new range of products to fill the gap

The outcome was that the company evolved a marketing strategy to design, manufacture and sell ranges of high quality products. This would enable it to compete in a different sector of the market where price was not the dominant order-winning criterion. Over the years, the company designed several ranges of new products and the mould introductions associated with this are summarised as Appendix I.2

4.61 MANUFACTURING

A brief outline of the process is shown as Appendix I.3. Starting with the raw materials, a moulded product was produced. Certain subsequent operations, such as removing the sprue (ie excess plastic) from the mould passageways - by hand, knife or drill, checking the quality of the moulding, and first packing operations, were all completed at the machine. The products were then transported in containers to the work-in-progress storage area. From there they were withdrawn as required by the Assembly Department, who completed any sub-assembly operations (eg gluing or welding components), assembly (eg fit lids to bases and attach labels), and finally packed into inner and outer cartons, prior to transportation to the Finished Goods Warehouse. With many of the products from the original product ranges the assembly and packing was completed during the moulding process as the work content was relatively small due to the bulk style of packaging involved.

4.62 RAW MATERIALS

The advent of the new range of products brought with it a significant increase in raw materials types and colours. In order to support the new product concept, more expensive materials were introduced and the colour range was widened. Also the 'old' products had tended to be moulded where close colour matching was not required and the material specification was less critical. Moreover, the 'new' products were clustered around a 'matching' range of products as a strategy to enhance sales with the purchaser having bought one item for the home would be more likely to buy another item of the set when next purchasing. This meant that it was necessary to maintain colour match over a long period of time.

4.63 DESIGN

Over the years, Design had expanded to become a separate function with a manager and four staff. Their job was to liaise with customers (often large department stores), agree design detail and then complete the drawings. The manager of the Tool Room then undertook to make or sub-contract the moulds and get them into production. The Tool Room always had one draughtsman who dealt with mould modifications.

Technical services

In the early 1970s, the technical support to the Mould Shop varied and included:-

1 Contribute to the design of a mould at the start of the mould-making process

2 Get new moulds to a production state and establish the settings and adjustments to be made in all future runs

3 Fine tune a mould at the start of its production run (very important in terms of productivity)

4 Help to determine the necessary modifications to a mould

Before the switch in product concept, those who provided technical services would have spent most of their day on task 3, but increasingly, due to the new product strategy, the technicians spent the majority of their time on the other three tasks.

In the early 1970s, the priority was to concentrate on thinning product wall thickness and reducing cycle times because, particularly with the long production runs associated with the old type products, this kept costs down. In addition, the mould was made as cheaply as possible and black plastic was used wherever possible so that re-ground plastic of mixed colours could be used. Also, contrasting colours for lids and bases was employed to avoid the need to colour match - a requirement which could only be consistently achieved if the lid and base for a product were produced on the same mould: in turn, this would increase the size of the mould (and hence machine) and increase overall costs.

The new products changed this. Wall thicknesses were increased to give products greater rigidity and substance, colour match became critical, lids and bases were the same colour, quality took precedence over cycle times, packaging became far more important and quality became the order of the day. The reprecussions of this on the shop floor were considerable. A new team had to be trained and pre-moulding treatment of material became necessary to achieve the necessary colour and quality standards.

Many exisiting machines were old and were often unable to meet or maintain the new product specifications. Until new machines could be justified, sanctioned and installed many preliminary operations were necessary to overcome the inadequacies of the old machines. As an estimate, due to wear and tear, only some 25% of the machines were up to the technical specifications required.

On the technical side, the existing fitters also had to be re-trained to set up moulds with complicated water circuits, heating sub-systems, temperature controls and complex core-pull and ejection systems. A new class of staff, the technician, became necessary. Recruitment from outside proved fruitless, and so the best setters took on this role with the best operators replacing them as setters.

4.64 MOULD SHOP

The product changes had brought with them a totally different manufacturing situation. In the early days of the product change strategy many technical difficulties had not been foreseen. These ranged from the inadequancies of many old machines to do the job through to the moulding properties of the new materials. Jobs had often to be allocated to a larger machine in order to achieve the required product specification (ie the increased locking pressure provided was needed to keep the mould closed during machine cycle hence avoiding 'flashing'). Also, great difficulties were being experienced with colour matching especially in the 'bright, modern' colours now being used.

Over the intervening years, many of these initial difficulties (and many more besides) were overcome but, in so doing had resulted in a lot of pressure, effort and cost. At times the company could have upto 7 or 8 of the machines working on new products which effectively meant no production and a complete loss of productive standard hours from some 30% of mould capacity. The problems of trying to complete the tasks of a development unit and a production unit under the same roof and calling on the same capacities and skills proved enormous. The pressure of achieving deadlines, particularly when little or no slack time had been allowed in the plan (the design/customer agreement phase always absorbed whatever slack there was), required all management's attention so that normal production had to "look after itself".

As shown in Appendix I.1 the available production capacity had shifted towards larger machines in actual numbers and markedly as a percentage of the total capacity available. To keep moulding costs down had moved the argument towards multi-impression moulds whereby every cycle produced a 'shot' with each of the impressions in the formed state (eg two lids or two bodies or two lids and two bodies and so on). Of course, multi-impression moulds are always much larger and much more sophisticated. These, in turn, required larger machines and accounted, in part, for the drift away from the machine mix of the early 1970s. In addition, mould changes and set-ups took longer. Details of a representative sample of products throughout the current range is given as Appendix I.4. Besides the cost advantages inherent in multi-purpose moulding, particularly with high volume production runs, another advantage gained was that it facilitated the moulding of a product which had more than one component and where colour matching was essential.

Part of the production management's job was to consider ways of reducing costs throughout the process wherever possible. Some of these suggestions came from marketing pressure in addition to the continuous flow of ideas from manufacturing itself with the aid of support services such as Work Study, Tool Room and Design. Appendix I.5 gives cost breakdowns for some representative products from across the current ranges.

The Assembly Department undertook sub-assembly, final assembly and packing, and was located away from the Mould Shop in a 50,000 square foot warehouse which also contained work-in-progress and some of the finished goods stock. The work of this department had increased with the need for packing and presentation which accompanied the new products. At the other extreme, any assembly or packing of the industrial products was mainly carried out at the machine. There were at the time of the research some 17 assembly benches and 3 sub-assembly locations, with 27 full-time and 16 part-time packers, and an indirect staff of three.

4.65 FINISHED GOODS WAREHOUSE

Although the product quantities had decreased since the early 1970s the requirement for warehousing was considerably higher. Reasons for this included:

1 Sub-contract industrial work for the group was moulded on a contract basis and shipped daily to the various companies.

2 The traditional homewares and industrial products were packed several together inside a box or polythene bag.

3 Components required to assemble the new ranges of products were greater.

4 The emphasis on quality meant that components had to be stacked with greater care.

5 The new products were packed individually in inner boxes which increased the space requirement at the finished goods stage.

Work-in-progress and finished goods warehousing capacity had been increased significantly as shown in Appendix I.6.

4.66 PRODUCTION CONTROL

The new range of products presented a new set of production control problems. The number of components and the assembly and packing requirement had increased the complexity of the process - see Appendix I.4. In addition, the uncertainty inherent in the mould-testing process, the

procedure for agreeing packaging, and the need to meet tight launch dates had added factors which made planning and control far more difficult.
In addition, the Marketing Department often required additional colours in order to increase sales in existing markets or break into new markets. An example of such a request is shown as Appendix I.7. These short runs and special colours often had target dates which necessitated fitting them in at all stages of the process at the expense of normal production runs. It proved most difficult to balance the two sets of priorities.

4.67 MARKETING

The Marketing Department was split into product areas and sub-divided into home and export. Each sub-division had a sales manager. It was well recognised that the improvement in the company's performance during the period (see Appendix I.8) was a direct consequence of the marketing strategy decision to go into the high quality product segment. The new product direction had enabled the company to compete successfully in a new sector of the market and, not only had it overcome the sales shortfall, but also underpinned the marked increase in profits. The markets for the two products the company currently manufactured and sold were very different. Sales of the old product were normally negotiated on a large volume contract with call-offs to meet the agreed customer deliveries. In the new markets, retail outlets hold the product ranges but the mix of products and colours meant that often the company needed to be able to supply orders within a few days. For, if the exact product wanted by customers was not available at the required time then often the sale was lost as the customer would spend the money on something else altogether.

4.68 MANUFACTURING STRATEGY REVIEW

The need to rethink the corporate position was an essential task and, a review of the 1973 to 1979 performance, clearly shows that sales (indexed on 1973) stood at 318 and profit before tax at 719. The company were concerned, however, with the increased inventory over the period with 1979 standing at 980 compared to its 1973 index.

The research initiative was, in part, concerned with this inventory position. However, in order to provide context, an early step was to ascertain the performance criteria which related to the 'old' and 'new' products, respectively. Appendix I.9 provides these insights.

A brief review of the order-winners for the new products shows that, through many of the actions taken earlier, the company had met the requirements of product concept, quality and design leadership through its relevant investment in processes and infrastructure. It also identified that the aspect of delivery speed had been met by increasingly higher levels of inventory. It was only in this way that the company could support the quick response times required (ie the criterion of delivery speed). For 'new' products, therefore, manufacturing had to take its part in the supply provision to the customer by holding inventory. The wide range of products and colours made it impossible for a retail outlet to hold all products in all colours.

4.69 THE IMPLICATIONS FOR MANUFACTURING OF PROVIDING THE ORDER-WINNERS FOR 'OLD' PRODUCTS

Manufacturing's support for these markets is to provide low-cost manufacturing. It has done this by concentrating its efforts in the area of highest costs - see Appendix I.10. It kept costs down as follows-

- raw materials
  - thin sections
  - lower grade of raw materials
  - limited colour range lead to few colour changes and associated material losses
  - use of black allowed the opportunity to use mixed colour re-grind
- moulding costs
  - long production runs with fewer colour changes and associated production losses
  - no colour matching betwee nlids and bases meant that lids could be run separately from bases. This, in turn, meant that the cycle time for lids could be faster (the mould takes a shorter time to fill and therefore can cycle at a faster speed) and need not be tied to the slower cycle time for bases as with the 'new' products
  - multi-impression moulds, with average production runs of 155 and 276 hours were eminently sensible as a way to reduce costs and, more importantly, release capacity - see Appendix I.11.
- assemble and packing
  - products were tapered to allow stacking and associated bulk packing - one outer (eg a polythene bag) would typically contain 6 or 12 products
  - bulk packaging also provided the opportunity to pack on the moulding machines as the packing need was only once per 6 or 12 cycles - hence no additional packing costs

- nesting products inside one another meant lower space requirements and associated warehouse costs.

It can be seen, therefore, that the company's manufacturing strategy for 'old' products supported the relevant order-winner.

4.70 THE IMPLICATIONS FOR MANUFACTURING OF PROVIDING THE ORDER-WINNERS FOR 'NEW' PRODUCTS

The new products which were the most difficult for manufacturing to provide were those which have the following characteristics

a) the lowest product demand in a range
b) the lowest colour demand in a range

This was because these represented very low production volumes especially compared to the 'old products'. Furthermore, the average volume for new products was significantly smaller (at 64, 56, 76 and 62 hours) than for old products (at 276 and 155) hours - see Appendix I.11. In addition, the demand for the low-low products would be tiny especially given the increased mould and colour change times. The trade-offs faced by manufacturing therefore, have been between loss of capacity and very high excess costs as shown in Appendix I.66 which relates manufacturing performance when moulding very low volumes of sample colours for marketing and inventory.

Manufacturing's decisions had been to produce inventory. Thus, finished goods inventory was not only large but it was suspect in terms of potential obsolescence in what was a fashion market. This now reflects the extent of the company's inventory problem. For, if the inventory was suspect, so was the company's profit and overall performance, a fact which reversed the company's view of its success in the period.

By going back to the relevant order-winning criteria for 'new' products, it became clear that manufacturing had supported these criteria effectively and the overall corporate performance was sound. The only problem was the high level of inventory holding especially given the now apparent slow-moving/obsolete nature of much of this investment outlined above.

The question facing the company concerned whether there was an alternative manufacturing strategy for 'new' products to the one currently pursued which would support the corporate marketing requirement of delivery speed without the severe disadvantage of creating slow-moving/obsolete inventory.

Reviewing some of the background factors helps to build a picture of what had happened

a) the company had pursued a policy of multi-impression moulds, other than those where there is a colour problem matching lids to bases

b) large moulds need larger machines - hence the machine mix change between 1972 and 1979 given as Appendix I.1.

c) when a company has large machines it will increase the tendency to design large moulds in order to create a fit between moulds and machines. Hence, the move towards large machines is self-reinforcing

d) the wide colour range and wider product range philosophy created a situation of shorter production runs involving more colour changes - see Appendix I.4 for production run information and in the increased colours involved in the company.

e) large moulds resulted in longer set-up and colour changes (see Appendix I.4). The large moulds and large machine philosophy further emphasised the inflexibility of the process and the unfavourable ratio between set-up time and run length. To correct this, manufacturing artificially increased production volumes by making inventory.

f) this led manufacturing into a finished goods inventory policy as the only way to support the delivery speed criterion in a situation where small production volumes created large excesses and loss of effective capacity through the high levels of down-time incurred with set-ups.

g) similarly, the policy of multi-impression moulding increased mould size and, more importantly, reduced production run lengths.

h) however, producing a lid and base on the same mould whilst necessary for colour matching did not decrease the production run length as only one product would be made per shot.

i) the new products were not price sensitive and moulding costs were not an important part of total costs.

An alternative manufacturing strategy for new products was, therefore, to use small, non multi-impression (except for colour matching lids and bases, but see h) above) moulds and smaller machines. This would reduce set-up times and enable the company to produce smaller order quantities and hence reduce inventory. In addition, this perspective also seeks a review by the marketing function of its product and colour range strategy in order to check whether, in overall terms, it would make more business sense to systematically cull out low selling items.

In reality, the problems facing the company included the fact that it had already made a sizeable investment and that to move to smaller moulds for existing new products would require fresh investment in both machines and moulds. Therefore, the size of investment involved also meant that the company would need time to reverse this trend.

Following these insights, the company undertook a change in direction with regard to its machine and mould tool investments. For its 'old' products, it continued to pursue its policy of designing multi-impression moulds which often necessitated correspondingly large machines. For its new products it began to build single impression moulds (except where a product had two or more moulded parts of the same colour) with an emphasis on fast change-overs. In turn, this reduced the machine size requirement which needed to be reflected in its investment policy. In addition, the company also had to appreciate that much of its high, current finished goods inventory holding was slow-moving and potentially obsolete.

The outcome of these deliberations was

- a dramatic fall in profits over the following two years due to inventory write-offs
- a balanced machine investment programme to reflect the needs of the two different markets. This took five to six years to finalise due to the heavy investment the company had already made not only in machines but also in mould tools

Finally, the outcome of a manufacturing strategy review is to help enable decisions to be made which embrace relevant functional perspectives. Given the difficulties faced in manufacturing to meet low volume products in low colours, then a systematic review of products and colours within existing ranges was undertaken on a regular basis with the purpose of questioning the rationale for retaining low selling items as part of the current catalogue. In this way, what was in the past considered to be a sacrosanct element of marketing philosophy was rigorously scrutinised and became subservient to the corporate good.

4.7 DEVELOPING A MANUFACTURING STRATEGY : PRECISION STEEL*

Precision Steel (PSL)** sold high-quality sections in a wide range of standard steel specifications together with customer-specified material requirements. It was part of Harbridge Industries**, a large group of companies with a wide range of interests including shipping, civil engineering, electronics, fabrication and engineering as well as steel processing. PSL was established in 1932 to roll precision steel sections for the electric motor industry.

Although many aspects of its activities have since changed, PSL's business still principally constitutes the rerolling of steel sections, using hot and cold processes, in a variety of steel specifications, and up to a maximum section height of 250mm. Due to falling demand and subsequent plant closures, PSL found itself, by the late 1970s (like many of its European counterparts) in a near monopoly position, as it was now the only supplier based in the United Kingdom. However, similar businesses in Europe were always keen to export to the UK, particularly to high-volume (ton) users.

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* This research was the first in-company analysis which formed part of a SERC grant awarded to the author. Detailed data collection was partly completed by a research assistant.

**The company names have been disguised.

4.71 PSL's MARKETS

PSL bought steel sections from a limited number of suppliers (principally British Steel), then sold rerolled precision sections into three market segments with different characteritics. These were electric motors, stockist steel sections and customised sections, which are described below.

4.711 Electric Motors

PSL's traditional market was to provide steel sections for electric motors. While demand for this market had fallen in the last fifteen years it still accounted for almost 50 percent of PSL's turnover (£s). Steel sections were rolled, and then subsequently precision machined by the customer. This market segment accounted for some 50,000 tonnes per year, and details of current and past sales are given in Appendix J.1.

4.712 Stockist Steel Sections

Sales in this market were for a range of standard sizes and shapes, all rolled from the one internationally specified steel, known by the company as PS2000. Both home and overseas customers, therefore, ordered from a standard catalogue, with items being differentiated only by size and shape.

In order to compensate for the falling sales experienced in the electric motor market, the stockist steel segment had been built up over the last fifteen years. The annual volumes processed in 1985 totalled 30,000 tonnes and details of representative orders are given in Appendix J.2. PSL currently supplied five major UK stockists and about 50 stockists overseas. In 1984, PSL had received a major contract from a French Company, Gambert Fabrique (GF), which yielded orders totalling 8,000 tonnes in the following years.

Apparently running at a substantial loss in its steel rerolling business, GF decided in 1983, to close its own rolling mill, having negotiated a contract with PSL to supply its standard steel sections, using steel PS2000. Gambert sold a wide range of products and was a large exporter of engineering supplies and metal sections (steel, brass and aluminium). It distributed these by a well-developed container service to its own depots and clients throughout the world.

The negotiations with Gambert resulted in agreed prices and terms for delivery by PSL to its main distribution centre in Brest, an industrial port in northern France. Appendices J.3 and J.4 give data to allow a comparison to be drawn with other products in this segment. Since 1983, PSL initiated discussions on the possibility of direct supply to some of GF's depots. The reason for this was that the GF contract was an important part of the company's customer portfolio. The annual volumes were substantial, characterised by relatively large order quantities and stable schedules. But, the trade-off had been low prices. However marketing saw the opportunity of supplying direct to GF's depots in one or more countries. The direct gains for Gambert were reduced distribution costs and for PSL an increase in price. This change was initiated in early 1984, for UK and Denmark depots with each buying about 450 tonnes per year. Having received permission to negotiate directly with these two parts of the Gambert organization, PSL was able to satisfactorily agree higher prices than for similar products, due to the fact that GF passed on distribution costs to its depots as well as adding its own margin. PSL was now able, therefore, to take some of that additional margin, and still offer a favourable price for direct supply (see Appendices J.3 and J.4). As a result of this initial success, PSL's marketing policy was to encourage this, a fact supported by a recent marketing report completed by an outside consultancy firm, which highlighted this as one of the major planks on which the company should build. Marketing, as a result, had identified the next areas as Brazil, Italy and West Germany

4.713 Customised Sections

The decline in overall sales had stimulated the need for PSL to increase sales in the customised sections segment of its markets. Customised sections business referred to orders which catered for the specific needs of a wide range of manufacturing businesses, including automotive components (eg struts), agricultural machinery and oil rig fabrication, as well as general engineering. The growth was based on converting customers from using non-precision, standard steel sections requiring extensive and costly machining and heat treatment, to purpose-rolled sections to meet their specifications in terms of dimensional tolerance, steel specification and heat treatment requirements. PSL's sales force had, over the last few years, developed a broader technical knowledge in order to help increase PSL's penetration in these markets. Orders could, however, involve both standard and special steels, but size and shape would always be specified by, and therefore special to, each customer. Many customers, however, placed repeat orders for the same product, often on a call-off or schedule basis. Most requirements could be met by the hot rolling process* and a representative sample of orders as given in Appendix J.5.

Sales in this market segment totalled 10,000 tonnes in 1985, 85 per cent of which went to UK companies, with the remainder sent to all parts of the world. An important element of this growth came from sales to the oil industry.

4.72 MANUFACTURING

Steel sections passed through a series of processes, which are now briefly described. Orders differ and whereas all products go through the hot rolling

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*Hot rolling was a less expensive process than cold rolling and, therefore, products were designed, where possible, to be made in a hot-rolled format stage, requirements from then on varied in accordance with the specification. Individual customer orders were cumulated, wherever possible, by input height (often referred to as billet size) in order to maximise the tonnage processed through the high-volume, hot mills. The task in the production planning office, therefore, was to combine together quantities of the same billet size and programme these through the hot mills in order to minimise the number of major and minor change-overs (explained later) in line with customer delivery requirements. Following this initial stage through which all steel was processed, customer orders were then separated, and followed the individual process requirements to completion.

4.721 Hot rolling

In 1986, two hot rolling mills were in use. One was installed in 1969 and the second in 1976 to replace earlier mill capacity, which had gradually been phased out. While the basic layout for hot rolling was similar, the process capabilities were different. This difference concerned the height and length of steel sections which could be processed.

4.722 Hot roll finishing

All products went through the hot roll finishing section. The processes were simple and the set-up times were short. After initial cooling, the steel sections were lifted by an overhead crane into the work-in-progress warehousing area. From this warehousing area, all products followed their own specified routing, according to the process requirements involved.

4.723 Cold rolling

About one third of all products were cold rolled. The orders were drawn from the work-in-progress stock after hot roll finishing. These processes enabled higher levels of accuracy to be achieved, particularly where the product specification called for thinner sections. They all required very long set-up times, and involved expensive tooling. The specialised tooling had a three month lead time from the suppliers and, therefore, needed very careful planning. In addition, there was a disproportionate amount of tool wear at the start of a production run, until fine adjustments could be achieved.

4.724 Other auxilliary processes

There were several additional processes involved, none of which have long set -up or process times. They included cold roll finishing, heat treatment, cutting to precise lengths, and specified packing prior to despatch. Not all products went through all processes.

4.73 LEAD TIME CALCULATIONS

The lead times used by sales in quotations were agreed annually by the sales and production directors, being occasionally adjusted as necessary by the production planning office, if overload situations seemed to be arising. As of February 1986 the following norms were used as a basis for calculating lead times on which delivery promises were then made: 10 weeks were allowed for the purchase of non-standard steel, 4 weeks for hot rolling, 1 week for standard heat treatment and finishing and 4 weeks for cold rolling. Non-standard, finishing process lead times were calculated for each job on the basis of an assessment of the complexity involved, and the degree of overall speed required by the potential customer.

In all markets, where customers required quicker deliveries than the total based on the above norms, shorter lead times for customer quotations were agreed by the manager of the production planning office. This was achieved by identifying areas of process time reduction, based on current and future loading, experience and judgment. In all cases, delivery was quoted as "ex-works" (the standard practice for the industry) and did not, therefore, include delivery arrangements. See Appendices J.6 to J.8 which give details of actual deliveries in a representative period.

Standard steels were assumed by the production planning office to be available from PSL raw material stock holdings, and thus no allowance was made in sales quotations involving standard steels to cover purchase lead time.* The stock of each size and specification of standard steel was tightly controlled by the planning manager, using simple controls, based on average usage for the last three months, current stock, and estimates of forward demand. Steel delivery was normally requested and acknowledged by suppliers as being 10 weeks from the order date. (See Appendices J.9 and J.10 for information on the delivery performance of PSL's steel suppliers).

4.74 PROCESS YIELDS

Process yield was defined as saleable output, divided by the input of raw material, and expressed as a percentage. The yields achieved by each different process were closely monitored every month, and were reported by the market category. Losses (some of which were unpredictable) arose from oxidation (scale losses), damage in the process plant, cutting losses in the finishing section, and quality rejects (dimensional, surface finish and metallurgical). All losses were closely monitored and investigated. They were accounted for in the estimation procedure when calculating material

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*Most standard steels are kept in stock as explained in the notes to Appendix J.9

requirements and order pricing. Yields currently used in these calculations were based on information gathered over the last 12 months, and averaged 92 per cent for the electric motor and stockist steel sections markets and about 85 percent for customised sections.

Orders were received in the sales department where they were recorded before being passed through to the production planning office. Orders were then collated by input height (ie billet size) required, and loaded onto the hot mills within a four-week programme.*

This resulted in steel sizes being processed once in each four-week cycle, in order to maintain agreed target levels of mill utilization. The procedure, therefore, was to sequence orders so as to minimise size of section changes and so reduce cumulative set-up times within a cycle. Appendix J.11 shows a typical hot mill rolling programme.

After the rolling stage, each order would then be routed according to the necessary finishing process operations to be completed. Due to the varying order quantities involved, jobs in excess of five tons would have to be split down after hot rolling, due to the crane lifting limitations detailed earlier.

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*Note: thus works orders for the same size (by the input height) of steel (the material specification was not normally a factor to be taken into account when compiling hot mill programmes) were grouped together to provide as large a quantity to be rolled as possible. However, as volumes declined, programmed quantities in the same period would decline, especially where the delivery speed element of a market was becoming important. In these latter situtions, the steel would, of course, have to be programmed into the hot mills to meet the customer delivery date, rather than to meet the programming rules used in the planning department. This would lead to lower production volumes and/or more frequent mill changes. Furthermore, when cumulative orders for the same steel size had been rolled the individual orders were then separated to follow their own routing through the remaining process in line with each product specification.

The result was that delays occurred in late production stages, when supervisors from these sections had to re-group part orders prior to processing, in order to avoid additional set-ups.

4.8 CORPORATE DECISIONS AND FUTURE MARKETS

The company recognised the overall decline in sales volumes but had sustained sales revenues by growing other segments to compensate for the decline in electric motor sales. The problem it faced at the time of the research was to decide on the appropriate future action to maintain its current business performance level.

One of the keys to this was seen to be in its choice of marketing strategies. It was partly for this reason that the company had sought advice from an outside consulting firm. The report gave strong support for two of the marketing initiatives of recent years -

a) To increase the number of direct delivery arrangements with Gambert Fabrique

b) To increase sales in the Customised Section Market and for this to be the large growth area of the future

4.9 MANUFACTURING STRATEGY REVIEW

Related to the two marketing initiatives detailed above with regard to Gambert Fabrique and the Customised Sections Market, a review of the implications for manufacturing was completed.

4.91 BACKGROUND ISSUES

• Volumes (tonnes)

The total tonnage of processed steel had remained approximately the same since 1975 although the market segments had changed during this time as illustrated in Appendix J.12.

However, this was not (as far as manufacturing was concerned) the critical issue. The change which has taken place was that concerning order size. Whereas in 1975, 85% of total volumes had an average order quantity of 14.3 tonnes or more, in1985, 80% had an average order quantity of 7.3 tonnes or less. The majority of PSL's business, therefore, had an average order quantity in 1985 of about half of what it was a decade before - Appendix J.12 gives details.

In addition, PSL's decision on hot mill investment would have been made in line with its perception of market volumes at the time of the decision - Mill C in 1969 and Mill D which was constructed in 1976 to provide efficient capacity for the high volume Electric Motors market. Thus, manufacturing now had the problem of coping with the incremental fall in average order quantity (tonnes) since the current hot mill capacity had been constructed, a trend which was expected to continue in the future.

• Delivery reliability

Appendix J.13 reveals that based on this representative sample for all markets of the 89 orders involved, 33 (or 37%) were one or more weeks late with almost 5% at four or more weeks behind schedule (the worst example being works order number C187 for a special steel Customised Section order which was seven weeks late). This needs to be set against the order winning and qualifying criteria analysis provided in Appendix J.14 for the two marketing strategy initiatives already detailed in section 4.7.

4.92 GAMBERT FABRIQUE

The rationale for the Gambert Fabrique (GF) initiative to deliver direct to its depots was in order to increase price and margin and in that way reduce the weighting currently given to price, which Appendices J.14 and J.15 reflect. However, the trade-off had been a significant reduction in average order quantities per size from 19.7 to 11.6 tonnes for GF overall with the UK and Denmark as low as 3.9 tonnes (see Appendix J.16). Furthermore, as the company cumulated all the same sizes for hot mill processing then as GF and its depots would order at different times, then processing volumes would be smaller, and this within a context of the overall volume reduction over the period 1975-85, as illustrated previously in Appendix J.12. Consequently, if the marketing strategy to increase direct supply was maintained then it would lead to further reductions in processing volumes. The knock-on effect was that the cost structure of current GF work would have to be recalculated - a fact which would affect the figures given in Appendix J.15. In addition, this would lead to a further overall decline in processed volumes and the increase in costs which would result. Manufacturing would, therefore, have to increasingly strike a balance between cumulating volumes, the impact on delivery reliability and speed, reduced contribution resulting from lower average order quantities, and an increased level of inventory.

The policy of market and volume fragmentation was also likely to lead to less stable schedules overall. Although GF (France) schedule arrangements may well remain stable in the forseeable future, as order quantities reduced then it would increase the instability within GF schedules. With regard to direct supply to the UK and Denmark then these features were already apparent:

- delivery lead-times were shorter (see Appendix J.17)
- as the scale of each GF depot was considerably smaller than the original parent operation, then inventory holdings would be smaller and more susceptable to stock-outs. The result of this would be increased pressure on schedules, delivery speed and requests for changes
- the outcome would be an increase in overall costs and pressure on meeting delivery performance

Furthermore, corporate discussion led to the following conclusions concerning price structures. There was a distinct possibility that the breakdown of the original GF (France) supply to its dependent depots may well have also severed the umbilical cord between parent company and dependent outlet. With classic pressure by organisations on the performance of its subsidiaries, then it must be anticipated by PSL that their initiative to raise margins may, in turn, lead to localised competition. GF's subsidiary depots, in order to improve their own performance, would undoubtedly look to price competition as a prime source to achieve this. If this happened then it would lead to an erosion of the higher contributions currently enjoyed. Furthermore, indigeneous suppliers to GF's depots would also have an inherent geographical advantage which would work against PSL in terms of delivery speed and the universal push to reduce inventory levels which GF's subsidiaries could also well have as part of their own goals.

Although traditional commercial arrangements can be inherently binding, once the pattern is broken, the domino effects will often take effect. PSL's marketing initiative would help to bring about this situation which would, in turn, impact on its volumes and order quantities.

4.921 The manufacturing implications of market and volume fragmentation

PSL's high volume processes were having to cope with lower order quantities as a natural part of the development in its markets. The pattern of declining volumes was characterstic of many manufacturing industries as the changes took place in markets throughout the world. However, although the initiative to supply direct to depots may make marketing sense, it would directly accelerate volume decline in what was now the highest average order quantity part of PSL's business. Smaller volumes = higher costs = lower contribution.

This impact, of course, was corporate wide in its consequences and, therefore, must be reviewed in terms of the business as a whole.

4.93 CUSTOMISED SECTIONS MARKET

This is a make to order market which involved the processing of both standard and special steels. Although average order quantities per size had fallen from 16.6 in 1975 to 9.4 in 1985, apart from Gambert Fabrique, Customised Sections had the highest average order quantity. It was not a price sensitive market (see Appendix J.15) but, as with other markets, placed delivery reliability as an important, order-losing sensitive qualifier. Delivery speed was also, for some orders, an order-winning criterion. Given that qualifiers were universal for all orders in this segment, then the important dimensions which distinguish order differences were the type of steel and the issue of delivery speed. The marketing description of this segment (viz Customised Sections) was based upon customer type. However, from a manufacturing point of view, this was of little value in trying to determine the fit between market characteristics and manufacturing's ability to support these needs. Thus, it was important for the company to recognise that, from a manufacturing perspective, this market comprised four different segments as follows

A Standard steels where delivery speed was not an order-winning criterion
B Standard steels where delivery speed was an order-winning criterion
C Special steels where delivery speed was not an order-winning criterion.
D Special steels where delivery speed was an order-winning criterion.

An analysis of Appendix J.8 needs to recognise that whereas the processing of orders for standard steel would not normally involve a material delivery element within the total lead time (as with most orders in the Electric Motors and Stockist Steel markets), orders involving special steels would. Of the 30 representative orders for which details had been given 14 were for standard steels of which 4 were required in less than 5 weeks, a fact which was indicative of the delivery speed element referred to in the case study narrative.

On three of these four occasions PSL failed to meet the shorter lead time commitment. With special steels, the gap between the works order being raised to the required and acknowledged delivery date was much higher at between 12 and 20 weeks reflecting the steel delivery component of total lead time.

However, as delivery lead time for special (ie non-standard) steels had an allowed time of 10 weeks then this element of total lead time needed to be subtracted from the 12 to 19 weeks delivery gap in order to establish the extent of the delivery speed nature involved in this category of customer orders. Such an analysis showed that of the 16 orders for special steels, two were required in less than 14 weeks (ie 4 weeks less net delivery lead time) and both were delivered late. Overall then, 6 (or 20%) of this representative sample had a delivery speed element within the order-winning criterion for this market.

4.931 Two tier risk when delivery speed is an order-winning criterion

When companies enter markets in which delivery speed is, or is becoming, an important order-winning criterion then it is critical that they review their current or intended marketing strategy if manufacturing's provision of this delivery criterion involves a two tier risk factor.

This is pertinent to PSL in terms of that segment of its Customised Sections market which involves delivery speed and special steel. Orders with these features combine a two tier risk factor associated with special steels within the time constraints associated with delivery speed as follows:

• uncertainty within the suppliers' manufacturing process due to the first-time nature of a special steel	**PLUS**	• uncertainty within PSL's manufacturing process due to the first-time nature of a special steel

Given the synergy (1+1>2) which would result from these two uncertainties, then PSL should question a marketing strategy which took them into orders with these characteristics if delivery speed (or orders where delivery promises rely on manufacturing meeting the scheduling norms in both supplier and internal processes) was an order-winning criterion. To do so would result in a poor delivery performance, a tarnished reputation in the market and, undoubtedly, excess manufacturing costs.

Consequently, PSL would need its marketing strategy within Customised Sections to line up with the recognition of two tier risk - Appendix J.18

summarises the delivery performance within the four segments of the Customised Sections market. This anlaysis clearly shows:

- the distinctly worse performance for those two categories where delivery speed was an order winning criterion (Categories B & D - see page 149)

- the problems of process uncertainty where special steels were involved (Categories C & D), and

- the distinctly poor performance where the features of delivery speed and special steels were brought together (Category D)

4.94 CORPORATE OUTCOMES

The strategic perspectives of functions need to be placed within an appropriate, corporate context. Only in this way will functional differences be able to be resolved at the business level and decisions reflect what is best for a firm overall.

The approach developed and used within this research stresses the iterative nature of manufacturing stategy within the corporate debate and identifies this part of the procedure as an integral part of the methodology (pp70-76). As with the HQ Injection Moulding example, the outcomes for PSL also illustrate this feature of the approach. The manufacturing and marketing responses which followed the research application reflected the corporate-orientated outcomes of the strategic debate which took place.

4.941 The Gambert Fabrique initiative

Within the context of overall, declining volumes and given the volume fragmentation which had (and would continue to) occurred, the company decided not to pursue the strategic option of extending direct delivery to other Gambert Fabrique depots.

4.942 Customised Sections

Given the growth potential and relatively high margin nature of these orders it was important for manufacturing and marketing to work together to increase sales in this segment. Manufacturing's principal task was to reduce total lead times in order to make delivery speed orders into non-delivery speed orders. Key manufacturing areas for improvement were

- investing in the hot mills to extend the range of both mills to cover all sizes and to allow for orders to be cycled on a two, rather than four, week basis

- holding finished goods inventory for selected, high volume standard items and "selling" the feature of fast response to customers

- reviewing raw material inventory holding to minimise the investment on the one hand and to ensure that what was held reflected known/ forecast sales on the other

- reduce lead times in the order processing system down to one day with reporting on an exception basis

The key marketing response was to review all incoming, customer orders into the four segments identified earlier (p159). In this way discussion could be initiated with the customer and explanations given regarding segment C and, particularly, segment D. In this way, customers could be advised of the business-related features embodied in their order and expectations linked to realistic lead times where orders were placed.

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APPENDIX G

SOME OF THE CONTRIBUTIONS BY HAYES AND WHEELWRIGHT TO THE DEVELOPMENT OF MANUFACTURING STRATEGY

This appendix gives more details on some of the contributions by Hayes and Wheelwright on the developments in manufacturing strategy and referred to in the chapter narrative.

APPENDIX G.1

HAYES AND WHEELWRIGHT'S CONCEPT OF A CORPORATE MANUFACTURING STRATEGY

Dimensions of a Manufacturing Strategy	Individual Business Strategies			Examples of Generic (Corporate-Wide) Policies and Guidelines
	Business A[a]	Business B[a]	Business C[a]	
Capacity[b]	XXXXXX 000000 000000 000000	XXXXXX ////// ////// //////	XXXXXX ++++++ ++++++ ++++++	A common set of criteria to be used in developing/presenting an investment proposal Policies for the economic or competitive conditions required to plan/start/postpone capacity changes
Facilities[b]	XXXXXX XXXXXX XXXXXX 000000 000000	XXXXXX XXXXXX XXXXXX ////// //////	XXXXXX XXXXXX XXXXXX ++++++ ++++++	Parameters governing the size and location of individual facilities Guidelines for permanent reductions in capacity at mature facilities
Technology[b]	XXXXXX 000000 000000 000000 000000	XXXXXX ////// ////// ////// //////	XXXXXX ++++++ ++++++ ++++++ ++++++	Policies for the organization and layout of production processes Criteria for equipment selection and the levels of automation to be pursued
Vertical Integration[b]	XXXXXX 000000 000000	XXXXXX ////// //////	XXXXXX ++++++ ++++++	Policies for make/buy analysis and changes in backward integration Rules for establishing internal transfer prices
Work force[b]	XXXXXX XXXXXX XXXXXX 000000	XXXXXX XXXXXX XXXXXX //////	XXXXXX XXXXXX XXXXXX ++++++	Establishment of benefit packages and pay scales Policies on unionization, hiring, promotion, and employment stability
Quality[b]	XXXXXX XXXXXX 000000 000000	XXXXXX XXXXXX ////// //////	XXXXXX XXXXXX ++++++ ++++++	Standardized reports, reporting relationships and job definitions Guidelines on performance measures such as the cost of quality, field failures, and expected quality levels
Production planning/ Materials control[b]	XXXXXX XXXXXX XXXXXX 000000 000000	XXXXXX XXXXXX XXXXXX ////// //////	XXXXXX XXXXXX XXXXXX ++++++ ++++++	Parameters for manufacturing system specifications and hardware approval Rules for measuring and evaluating inventory performance
Organization[b]	XXXXXX 000000 000000	XXXXXX ////// //////	XXXXXX ++++++ ++++++	Definitions for job classifications and direct/indirect staffing levels Policies regarding manufacturing engineering support levels and use of outside services

[a] Each column represents the manufacturing strategy (pattern of manufacturing decisions) that complements a specific business strategy.
[b] Each row represents behavior, practices, and policies in that decision category that are consistent across businesses (indicated by XXXXXX), and those not consistent across all businesses.

Source: Hayes and Wheelwright (1984) pp36-7, Table 2-3

APPENDIX G.2

HAYES AND WHEELWRIGHT'S STAGES IN THE EVOLUTION OF MANUFACTURING'S STRATEGIC ROLE

Stage 1 - Minimize Manufacturing's Negative Potential: "Internally Neutral"

External experts are used in making decisions about strategic manufacturing issues
Internal management control systems are the primary means for monitoring manufacturing performance
Manufacturing is kept flexible and reactive

Stage 2 - Achieve Parity (Neutrality) with Competitors: "Externally Neutral"

"Industry Practice" is followed
The planning horizon for manufacturing investment decisions is extended to incorporate a single business cycle
Capital investment is regarded as the primary means for catching up to competition or achieving a competitive edge

Stage 3 - Provide Credible Support to the Business Strategy: "Internally Supportive"

Manufacturing investments are screened for consistency with the business strategy
Changes in business strategy are automatically translated into manufacturing implications
Longer-term manufacturing developments and trends are systematically addressed

Stage 4 - Pursue a Manufacturing-Based Competitive Advantage: "Externally Supportive"

Efforts are made to anticipate the potential of new manufacturing practices and technologies
Manufacturing is centrally involved in major marketing and engineering decisions
Long-range programs are pursued in order to acquire capabilities in advance of needs

Source: Hayes and Wheelwright (1984) pp36-7, Table 2-3

APPENDIX H

DETAILS OF THE PLANT-BASED APPLICATIONS COMPLETED DURING THE PERIOD OF THE RESEARCH BUT NOT USED HERE AS SPECIFIC EXAMPLES

Appendix H contains details of the thirty three plant-based applications completed during the period of the research. The details give year, country and industry in which the plant is based and principal areas of application.

APPENDIX H.1

OVERVIEW OF APPLICATIONS RE METHODOLOGY AND OTHER MANUFACTURING STRATEGY RESEARCH ISSUES FROM 1979-1989

Year	Country	Industry	Principal applications
1979	UK	Injection Moulding*	Methodololgy development
1980		Electronics	Process choice/methodology
1983		Telecommunications Automotive components	Focus and methodology development
1985	Canada	Packaging	Methodology development
	UK	Automotive components*	Product profiling
1986	Canada	Packaging	Methodology development
	UK	Railways	Infrastructure
		Steel*	Methodology development/ segmentation
	Canada	Packaging	Methodology development
1987	UK	Packaging Chemicals Aerospace	Methodology development and segmentation
	Canada	Packaging	
	UK	Blow moulding Aerospace Packaging	Product profiling Supplier relations Methodology development

1988	UK	Packaging	Methodology development and segmentation
	France	Packaging	
	UK	Aerospace	
	Canada	Packaging*	Product profiling
	UK	Tobacco*	
	Canada	Packaging	Methodology development
1989	UK	Packaging Electronics	Focus Process choice
	Canada	Packaging	Methodology development
	UK	Food	
		Electronics	Focus
	US	Furniture Service	Methodology development and segmentation
	France	Packaging	
	UK	Food Packaging	Focus Methodology development

* Used as illustrations in the body of the thesis

APPENDIX H.2

SUMMARIES OF THE APPLICATIONS DETAILED IN APPENDIX H.1

Year	Number of plants
1979	1
1980	1
1983	2
1985	2
1986	4
1987	7
1988	6
1989	10
TOTAL	33

Principal applications	Number of plants
Methodology development	22
Segmentation	11
Product profiling	4
Focus	4
Process choice	2
Infrastructure	1
Supplier relations	1
TOTAL	45*

* This exceeds 33 due to occasions when a plant embodied more than one application

APPENDIX I

DETAILS OF THE FRAMEWORK APPLICATION FOR HQ INJECTION MOULDING COMPANY

Appendix I contains supporting details for the research work completed in the first company reported here. In this way it gives the essential data on which the research application was based and the necessary background against which the research findings need to be set.

APPENDIX I.1

DETAILS OF INJECTION-MOULDING MACHINES

Below are details of the number of machines available in each machine group defined by the company. A typical machine is given in some detail in Note 2 below.

Machine Group	Number of Machines		
	1972	1979	New[1]
1	29	1	-
2	15	11	5
3	5	8	6
4	2	2	1
Total	51	22	12

Notes

1 Details of the 'new' machines in each group are:

Machine Group	Year of Purchase/New Machines 1973	1974	1975	1976	1977	1978	1979	Total
2	-	-	-	-	3	2	-	5
3	2	1	1	1	-	1	-	6
4	-	-	-	-	-	-	1	1

2

Machine Group	Features of an Average Machine Cost* (£000s)	shot weight (ozs)	locking pressure (tons)
1	80	10	200
2	103	45	450
3	120	60	600
4	175	150	600

* cost includes the purchase price of the machine and installation costs at 1980 prices

APPENDIX I.2

SUMMARY OF THE MOULDS INTRODUCED OR PLANNED SINCE 1973

Production Range		Number of Moulds	Production Range		Number of Moulds
Start Date	Type		Start Date	Type	
Apr 73	C	14	Aug	C	2
Jun	C	2	Aug	E	1
Sep	E	4	Sep	D	6
Sep	C	3	Sep	E	18
Sep	D	4	Nov	E	1
Mar 74	D	18	Mar 77	D	1
Mar	B	1	Jun	B	1
Jun	D	2	Jul	B	1
Jun	C	6	Sep	B	2
Sep	E	19	Sep	C	1
Sep	C	2	Dec	C	2
Sep	B	2	Dec	E	9
Oct	A	1	Mar 78	C	1
Oct	B	1	Mar	D	2
Aug 75	C	2	Mar	B	2
Sep	C	4	Mar	E	1
Oct	B	1	Jun	B	1
Oct	C	3	Sep	F	2
Dec	A	1	Sep	E	9
Dec	C	1	Dec	B	1
Feb 76	A	5	Dec	E	4
Mar	C	2	Jun 79	B	2
May	C	2	Sep	D	12
Jun	C	2	Oct	E	15
Jun	E	6	Feb 80	E	30
Jul	B	1			

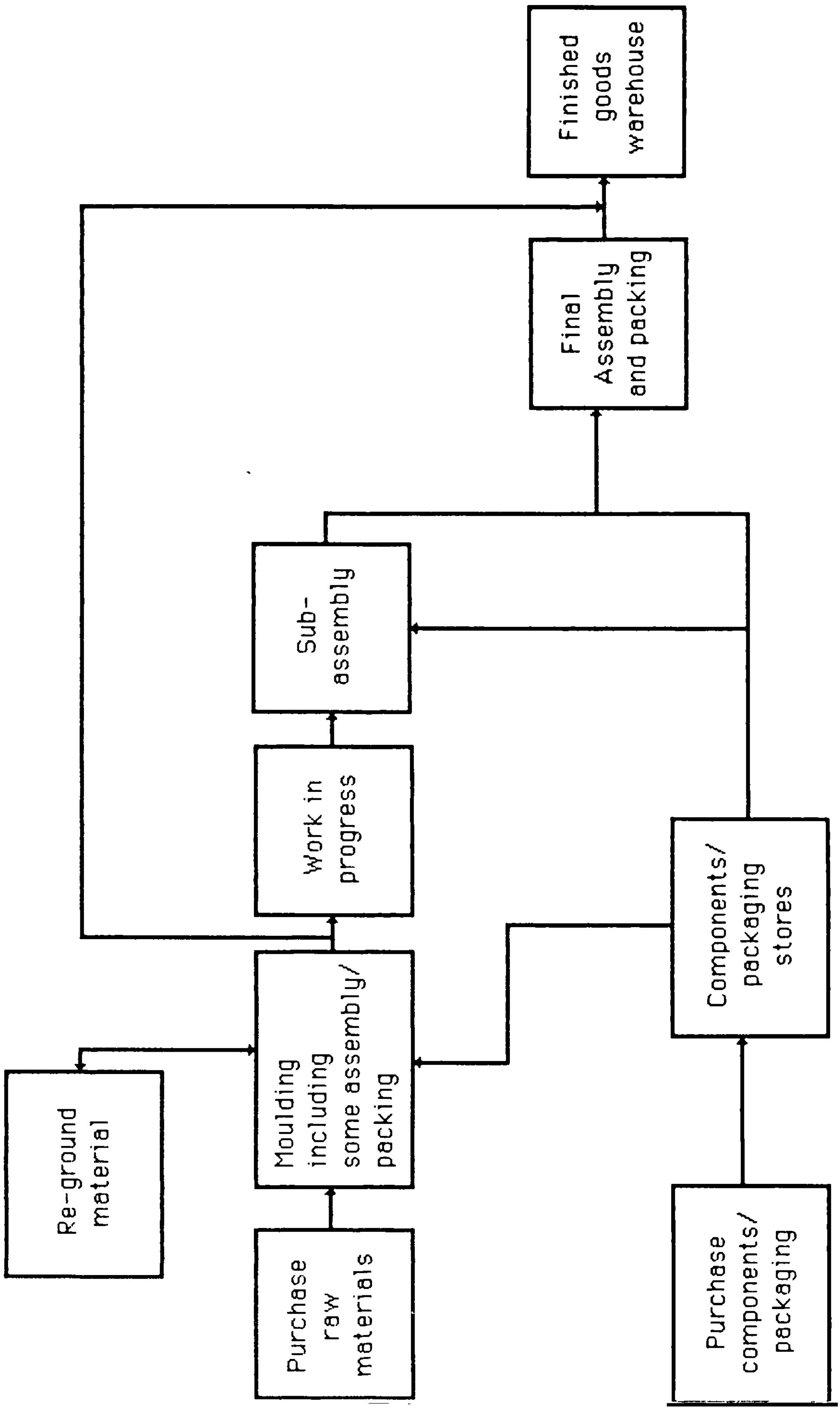
NOTES

1 Product range types A and B belong to the original (pre-1973) designs whilst C to F were of the revised (post-1973) designs. Further details are given in Attachment 5 under the column headed "Product Range"

2 The number of moulds indicates the number of different products within each range. However, in many instances, one mould will have two or more impressions on it so that in every moulding cycle one, two or more products would be made depending on the number of impressions on that mould

APPENDIX I.3

AN OUTLINE OF THE MANUFACTURING AND ASSEMBLY PROCESS



Note - all products do not go through each stage of the manufacturing and assembly process.

APPENDIX I.4

PRODUCTION SALES AND INVENTORY DETAILS ON SEVERAL PRODUCTS

Product range	Product (1)	Machine group	Number of: impressions	Number of: colours	Number of: mouldings (2)	Number of: components	When last moulded: months ago	When last moulded: colour changes	Production run (hours): last (1)	Production run (hours): average (4)	Production runs last 12 months	Hours to change (12): mould	Hours to change (12): colour	Annual sales (units)	Finished goods (13): units	Finished goods (13): colours	Outstanding orders (16): units	Outstanding orders (16): colours
(A) GENERAL OMEWARES original product concept	1132 Tray	2	2	1	1	3	27	1	1700	1700	-	2(½)	-	20,686	67,159	1	-	-
	2225 Bowl (5)	2	1	0	1	2	1	3	192	240	6	2(1)	2	159,120	33,769	8	-	-
	1138 Bucket (5)	3	1	8	2	2	6	3	138	138	1	3(1½)	2	13,236	5,829	5	-	-
	1386 Jug	2	1	1	2	3	2	1	190	147	1	3(1)	-	44,237	34,618	1	-	-
	1263 Tray (5)	2	1	0	2	5	5	4	70	120	4	2½(1)	1½	40,162	15,050	8	-	-
	2687 Tidy	3	1	2	2	4	1	2	124	82	7	7(3)	2	50,400	8,280	2	-	-
	2241 Bin	3	2	6	3	7	1	5	101	100	4	13(5)	2	47,646	3,642	5	195	1
	2366 Bin	3	1	1	2	2	-	1	156	120	6	7(1)	1	11,779	-	-	288	1
	1393 Box	2	2	2	2	2	1	1	190	83	6	2½(1)	1½	22,405	3,987	2	-	-
	1267 Tub	3	1	1	1	1	5	1	44	44	1	2½(1½)	1½	13,465	734	1	-	-
	8282 Bowl (6)	3	4	6	1	3	2	6	220	250	2	10(4)	2	57,840	480	6	-	-
(B) NDUSTRIAL OULDINGS -original product concept	6900 Board	2	1	2	1	1	0	2	144	144	1	1(-)	½	6,735	-	-	-	-
	6908 Basin	3	2	1	1	2	2	1	62	62	1	22(10)	-	-	-	-	-	-
	6074 Lid	2	1	1	1	2	3	1	45	45	1	3(1)	-	-	-	-	-	-
	6010 Tray	3	2	1	1	-	50	1	106	106	-	3(1)	-	-	-	-	-	-
	6085 Knob	1	2	5	1	1	16	2	125	125	-	2(½)	½	-	-	-	-	-
	6990 Frame	3	1	1	1	4	2	1	163	163	1	24(10)	-	-	-	-	-	-
	6491 Cap	1	6	1	1	1	6	1	110	511	6	2½(1)	-	533,318	-	-	48.703	1
	6209 Case	2	1	1	3	5	4	1	95	83	7	7(3)	-	65,159	1,152	1	-	-
	8860 Tray (7)	4	1	12	1	1	-	1	2400	371	10	9(3)	½	159,489	4,804	6	19,835	1
	8009 Case	3	2	2	1	1	8	2	60	54	2	11(5)	½	5,443	3,650	2	-	-
	8010 Tray	3	1	2	1	1	4	1	90	36	2	11(5)	½	2,741	717	1	-	-
(C) GENERAL OMEWARES revised product concept	3910 Container	3	1	10	2	5	1	3	134	87	9	4(2)	3	35,238	520	2	7,917	3
	3941 Rollholder	2	1	3	1	8	10	3	55	55	1	13(3)	3	3,312	610	2	432	1
	3995 Container	3	1	10	2	5	30	4	77	77	-	3½(2)	1½	157	108	2	-	-
	6115 No 4	3	4	6	1	5	14	5	20	20	-	9(1)	6	13,814	28,225	6	-	-
	6110 No 9	2	1	9	1	4	20	1	24	24	-	3(1)	2	1,242	6,660	8	-	-
	6246 No 28	4	2	12	1	4	1	5	81	39	9	7(3)	4	14,472	6,485	12	-	-
	6151 Jug	2	1	4	1	3	20	3	102	102	-	9(2)	2	3,284	1,035	2	209	2
	6313 Box	1	1	4	2	6	30	1	24	24	-	3½(2)	2	405	6,294	3	-	-
	6332 Rack	4	1	6	1	3	3	3	106	106	1	10(4)	3	18,453	2,489	5	-	-
	6846 Shelf	3	2	2	1	9	4	2	42	92	2	8(4)	2	10,598	2,003	2	-	-
	6463 Clock	3	1	4	4	10	14	3	78	78	-	2½(1)	1½	6,393	1,749	4	-	-
(D) BATHROOM RANGES -revised product concept	5426 Holder	3	2	10	2	7	-	2	67	155	14	4(2)	2	119,367	-	-	12,816	8
	5229 Dish	4	2	9	2	6	-	2	45	110	7	4(2)	2	40,819	966	4	4,196	4
	5624 Holder (8)	2	1	10	1	8	-	3	40	40	1	14(2)	2	-	3,240	3	3,240	3
	5315 Dish (8)	2	1	5	1	7	-	3	20	20	1	14(2)	2	-	1,080	3	1,050	3
	6213 Hook	2	2	10	2	6	17	2	47	47	-	4(2)	1½	2,018	12,725	8	-	-
	6420 Mirror	4	2	11	2	9	1	1	39	39	5	5(2)	1½	11,768	15,283	7	-	-
	6428 Holder	1	2	13	3	5	1	2	35	35	5	2½(1)	1	16,913	21,392	10	-	-
	6606 Beaker	3	2	5	2	6	1	2	33	50	3	5(2)	1½	24,244	18,785	4	3,000	1
	6397 Caddy	3	1	4	2	8	1	2	95	34	3	8(4)	1½	10,752	11,167	4	-	-
	6309 Mirror	4	1	4	1	8	1	3	43	32	4	4(2)	1½	9,720	3,994	3	1,500	1
(E) KITCHEN RANGES -revised product concept	4141 Bowl	4	2	4	1	4	2	2	60	80	8	3(1)	1½	58,850	12,280	4	-	-
	8284 L sieve (9)	3	2	4	1	7	1	3	100	35	8	3(1)	1½	39,638	96	1	8,222	3
	4150 S sieve (9)	2	2	4	1	7	1	3	100	63	8			35,450	233	1	1,607	2
	4155 L spoon (10)	3	2	4	1	4	3	4	367	117	4			74,020	49,017	3	-	-
	4156 S spoon (10)	3	2	4	1	4	3	4	367	140	4	6(3)	1½	98,828	4,961	2	608	1
	4161 Scraper (10)	4	4	4	1	4	3	4	367	144	4			119,765	26,666	3	-	-
	4159 Jug	2	1	4	1	4	3	3	141	72	7	9(4)	1½	54,022	4,764	4	-	-
	4219 Cutter (11)	2	8	4	3	4	3	4	90	47	5	4(2)	1½	162,492	188,261	4	-	-
	8424 Mould (11)	2	8	4	4	4	2	3	108	26	6	5(2)	1½	122,472	95,994	4	-	-
	4213 Holder	2	1	4	1	6	5	3	142	36	6	4(1)	1½	19,120	34,178	4	-	-
(F) GENERAL (15)	2849 Hanger	3	12	6	1	3	-	5	103	50	9	11(3)	2	540,615	58,333	6	-	-
	6049 Bracelet	[illegible]	4	6	1	2	22	4	74	74	-	[illegible]	1		[illegible]	-	-	-

APPENDIX I.4

PRODUCTION SALES AND INVENTORY DETAILS ON SEVERAL PRODUCTS

NOTES

1 In the case of several of these products there is more than one moulding involved (eg both a body and a lid) - here the principal moulding (eg the body) has been analysed as representative.

2 Number of mouldings refers to the actual separate mouldings (not by colour) involved in making up the product. Component refers to the number of different components.

3 If no production runs in the last 12 months, the last order has been taken as average.

4 The number of impressions on the mould is accounted for by giving a production value of x shots per hour (standard hours per 5 working days = 120).

5 As part of the 'revised production concept' the colour range of these products was increased from 3 to 8.

6 This product was in fact packed in assorted colours and held in finished stock as such.

7 The range of colours for this item was due to the fact that customers tended to prefer their own colour for reasons of brand image, recognition etc.

8 New product range - outstanding orders represent initial launch.

9 Both these products are on the same mould.

10 These three products are on the same mould.

11 Impressions are of different shapes - two sets of shapes x 4 impressions.

12 Hours to change a mould includes changing the mould and then the time taken to get the mould working to production and quality requirements which is shown in brackets. For example Tray 1132 2 (1/2) means 2 hours to change the mould and get it working into production and quality requirements. Of this 2 hours, the adjustment process to get it working to production and quality requirements after the mould change takes 1/2 hour.

13 The colours in stock are not the same colours as those required for outstanding orders.

14 The products shown here are considered to be representative of both their own and the total product range.

15 This product range is of the "Revised Product Concept".

16 Cols is short for colours.

APPENDIX I.5

COST DETAILS OF REPRESENTATIVE PRODUCTS

Product details		Cost details (pence per 12)							
range	item	raw materials	labour		packaging and components	mould depreciation	overheads		total
			moulding	assembly			moulding	general	
A	2225 Bowl	254	35	-	38	25	179	148	679
A	2687 Tidy	409	56	-	78	40	303	242	1128
A	2366 Bin	2103	142	-	272	160	787	957	4421
A	8282 Bowl	44	6	8	11	4	32	25	130
B	6491 Cap	9	-	-	1	1	15	8	34
B	8860 Tray	1621	88	-	668	116	491	695	3679
B	8009 Case	1093	73	-	515	83	406	496	2666
C	6846 No 28	1799	110	103	435	280	609	839	4175
C	6846 Shelf	457	79	106	764	108	438	324	2276
D	5426 Holder	288	105	69	311	100	508	300	1681
D	5624 Holder	163	92	88	272	77	440	232	1364
D	6420 Mirror	1942	139	334	2469	317	773	951	6925
D	6428 Mirror	578	165	78	786	173	812	518	3110
D	6606 Beaker	237	91	73	298	82	411	246	1438
E	8284 L sieve	250	48	49	409	20	112	61	949
E	8424 Mould	21	6	10	17	6	29	19	108
F	2849 Hanger	54	4	8	18	4	21	25	134

Notes

1 Raw material costs were normally adjusted twice a year

2 Moulding and assembly labour costs were based on calculated standard times

3 Mould depreication was a fixed % of the first stage costs which comprised Raw materials, Moulding overheads, Mould depreciation, Moulding labour

4 Moulding overheads were based on the machine size cost below:

Group	1	2	3	4
Moulding overhead allocation (£.p)	13.48	15.95	17.60	17.60

If a product was to be moulded on a machine in Group 1 then the moulding overhead allocation would be based on £13.48 and so on. These allocations included indirect moulding labour, production staff, development, factory, utilities, plant, depreciation, blocks, dies and plant repairs

5 General overheads were calculated as a fixed % of first stage cost

6 The product range abbeviations A to F are explained in the Notes to Appendix H.4

APPENDIX I.6

CHANGES IN COMPONENTS/PACKING, WORK-IN-PROGRESS AND FINISHED GOODS WAREHOUSING FOR THE PERIOD 1973-79

Warehousing	Date	Size (Sq feet)	Distance (Miles)	1979 Total (Sq Feet)
Components/ packing	1973	5000	-	
	1976 - 79	5000	-	10000
Work-in-progress	1973	9000	-	
	1977 - 79	9000	-	18000
Finished goods	1973	27000	-	
	1974	10000	20	
	1976	40000	1	87000
	1977	(10000)	20	
	1979	20000	3	

Note

The 1979 rented cost of warehousing was about £2.50 per square foot. All the above was rented at an average of about £2.00 per square foot. In 1977, the 10,000 square foot finished goods warehouse taken on in 1974 was sold.

APPENDIX I.7

PRODUCTION DETAILS FOR MARKETING SAMPLES IN NEW COLOURS

Product	Colour requests					Actual time taken (mins)		Allowed moulding standard time (minutes)
	beige	brown	blue	green	total	moulding	colour change	
4012 Dish	24	42	24	42	132	405	65	156
4013 Holder	20	42	24	42	128	550	100	152
4014 Beaker	24	42	24	42	132	480	60	111
4018 Holder	24	42	24	42	132	260	60	129
4019 Holder	24	42	24	42	132	670	110	132
4020 Sticks	40	42	30	42	154	270	60	137
4021 Ring	60	60	36	36	192	390	95	200
4023 Rack	20	36	20	24	100	1140	220	175
4028 Rail	24	42	24	42	132	445	60	139
4029 Frame	24	42	26	42	134	530	120	137
	284	432	256	396	1368	5120	950	1468

Note Colour change time was the total time taken to change from one colour to another in this production run. It is in addition to the actual moulding time given here

APPENDIX I.8

SOME FINANCIAL MANAGEMENT INFORMATION 1973-79
YEAR ENDED 31 DEC - ALL FIGURES £000s

	1973	1974	1975	1976	1977	1978	1979
FIXED ASSETS							
Plant	561	552	399	420	612	838	980
Moulds	102	130	170	180	320	584	620
	663	682	569	600	932	1422	1600
CURRENT ASSETS							
Inventory	262	532	1029	1259	1559	2243	2567
Debtors	483	798	842	817	1321	963	1373
	745	1330	1871	2076	2880	3206	3940
CURRENT LIABILITIES							
Creditors	626	532	628	1134	1774	1744	1765
Overdraft	2	480	412	42	38	284	575
	628	1012	1040	1176	1812	2028	2340
WORKING CAPITAL	117	318	831	900	1068	1178	1600
NET ASSETS EMPLOYED	780	1000	1400	1500	2000	2600	3200
FINANCED BY							
Share capital	50	50	50	50	50	50	50
Retained profit	280	420	530	570	830	1760	2660
	330	470	580	620	880	1810	2710
Group indebtedness	450	530	820	880	1120	790	490
Net capital employed	780	1000	1400	1500	2000	2600	3200
Net sales	2552	2872	4212	4466	5810	5394	8021
Net profit before tax	146	185	274	362	564	708	1050

NOTES

1 Working capital = current assets - current liabilities.

2 Net assets employed = fixed assets + working capital.

3 Any difference between the net profit for any year and the increase of retained profits was due to a transfer of profit to the Group.

APPENDIX I.9

RELEVANT ORDER-WINNING CRITERIA FOR THE COMPANY'S OLD AND NEW PRODUCTS

Order-winning criteria		Products 'old'	Products 'new'
Product concept	a) product range	-	***
	b) colour choice	-	***
	c) colour matching	-	***
Quality		-	***
Delivery	a) reliability	-	-
	b) speed	-	***
Price		***	-
Design leadership		-	***

Notes 1 As explained in Chapter 3 "Methodology", the use of 'stars' to indicate weighting was replaced in later developments due to the difficulty in identifying relative importance

2 It can also be seen here that, at this time, the failure to recognise the difference between qualifiers and order winners led, in this instance, to mixing these two dimensions of a market

APPENDIX I.10

AVERAGE COSTS FOR EACH PRODUCT RANGE

Product	Raw materials	Labour moulding	Labour assembly	Packing and components	Total
A	702	60	2	100	864
B	908	54	-	395	1357
C	1128	95	105	600	1928
D	642	118	128	827	1715
E	135	27	30	213	405
F	54	4	8	18	84

% TOTAL COSTS FOR EACH PRODUCT RANGE

A	81	7	-	12	100
B	67	4	-	29	100
C	59	5	5	31	100
D	38	7	7	48	100
E	33	7	7	53	100
F	64	5	10	21	100

Notes 1 Products A and B are the original product concept
2 Products C to F are the revised product concept
3 Source Appendix

APPENDIX I.11

ANALYSIS OF REPRESENTATIVE PRODUCTS

Product range	Number of representative products	Number of impressions						Number of		Average components	Production run (hours)	Hours to change	
		1	2	4	6	8+	av	colours	mouldings			mould	colour
General home-wares - original product concept	11	9	1	1	-	-	1.4	4.2	1.7	3.0	276	5.0	1.3
Industrial mouldings - original product concept	11	9	1	-	1	-	1.5	2.6	1.2	1.7	155	8.6	0.2
General home-wares - revised product concept	11	10	-	1	-	-	1.3	6.4	1.2	1.7	64	6.6	2.7
Bathroom ranges - revised product concept	10	9	1	-	-	-	1.1	8.1	1.8	7.0	56	6.9	1.8
Kitchen ranges - revised product concept (see Note 1)	10	4	3	1	-	2	3.0	4.0	1.5	4.8	76	4.9	1.5
General Products - revised product concept	2	-	-	1	-	1	8.0	6.0	1.0	2.5	62	6.5	1.5

Note 1 Includes two moulds which have 2 and 3 different products on each mould respectively
2 Source - an analysis of Appendix H.5

APPENDIX J

DETAILS OF THE FRAMEWORK APPLICATION FOR PRECISION STEEL

Appendix J contains supporting details for the research work completed in this second application of the methodology concerning the development of an appropriate manufacturing strategy statement for a business. As with Appendix H, it gives the essential data on which the research application was based and the necessary background against which the research findings need to be set.

APPENDIX J.1

PSL's CURRENT AND PAST SALES (TONNES) OF STEEL SECTIONS FOR THE ELECTRIC MOTOR MARKET

YEAR	1975	1979	1983	1984	1985
Total sales (tonnes)	79600	65300	55500	52000	50400
Average order quantity (tonnes)	286	205	235	220	190
Average number of sizes per order quantity	20	20	29	27	26

Notes

1 There were now seven different specifications (ie material propeties) of steel raw materials (in a different range of sizes) required by this market. Each specification in all sizes was normally held in stock by PSL. In 1975 there were only two specifications.

2 A typical order comprised several sizes of finished precision steel sections, but usually all of the same steel specification and finishing/heat treatment requirements. The various sizes would, however, be processed in separate Hot Mill programmes. Therefore, although an order may be for (say) 200 tonnes, as far as manufacturing was concerned it would be similar to (say) 20 different orders (ie one order per size) as similar sizes (and not one customer order) were processed through manufacturing.

3 Typical delivery lead times were 6-8 weeks from receipt of order.

APPENDIX J.2

PSL's CURRENT AND PAST SALES OF STOCKIST STEEL SECTIONS

YEAR	1975	1979	1983	1984	1985
Total sales (tonnes)	15100	17700	19400	28900	29700
Average order quantity (tonnes)	84	95	105	130	123
Average number of sizes per order quantity	17	20	24	25	23

Notes

1 The steel specification for this market was PS2000 only.

2 There were 140 International Standard Sizes in the stockists' range.

3 Gambert Fabrique (France) ordered (once a month) an average of 670 tonnes in 34 standard sizes (minimum 10 tonnes per size) for delivery 6/8 weeks from receipt of an order.

4 Gambert Fabrique (UK and Denmark) each ordered twice a month an average of 35 tonnes each in 9 sizes (minimum 3 tonnes per size) for delivery 4/6 weeks from receipt of an order.

5 Current delivery lead times for UK stockists were 6-8 weeks from receipt of an order.

APPENDIX J.3

SOME EXAMPLES OF TYPICAL INVOICED RATES PER TONNE - FEB 86

	BILLET SIZE (mm)	£/TONNE
a) Electric Motor	70	600
- XR7 material	110	500
	120	465
	140	420
	190	425
	250	430
b) Stockist Steel	70	570
- PSL's UK Stockists	100	490
	120	475
	140	465
	170	470
	250	450
c) Gambert Fabrique	85	420
- France	110	340
	130	320
	150	300
	190	300
	250	300
d) Gambert Fabrique	85	480
- UK	110	390
	130	360
	150	350
	190	340
	250	330
e) Customised section	85	810
- MK 200 steel	120	680
	190	610
	210	610

NOTES
1 All prices were corrected to ex-works equivalents.
2 MK 200 was an expensive alloy steel.

APPENDIX J.4

SUMMARY OF ESTIMATED VARIABLE COST £ PER TONNE IN VARIOUS MARKETS, AND FOR DIFFERENT TONNAGES PER SIZE, BASED ON JAN 86 COSTS

		INPUT STEEL HEIGHT (MM)					
		70-85	100-110	120-130	140-150	170-190	210-250
ELECTRIC MOTORS	5 tonnes	490	411	385	350	355	360
(typical steel	10 tonnes	460	386	363	330	335	340
specification XR7)	20 tonnes	445	376	350	320	330	335
STOCKIST STEEL	5 tonnes	410	336	314	290	295	300
(PS2000 steel)	10 tonnes	380	316	298	280	285	290
	20 tonnes	365	306	290	275	280	285
CUSTOMISED SECTIONS	5 tonnes	635	550	520	500	490	490
	10 tonnes	600	525	500	480	470	470
	20 tonnes	580	510	485	460	455	455

NOTE - Variable cost included all direct labour, materials and other direct costs (eg variable energy costs) and an allowance for size changes between items on a programme. It also allowed for average yield losses for the market category.

APPENDIX J.5

PSL's CURRENT AND PAST SALES OF CUSTOMISED SECTIONS

YEAR	1975	1979	1983	1984	1985
Total sales (tonnes)	4200	9600	18200	18600	20400
Average order quantity (tonnes)	18.3	16.6	11.2	11.8	12.2
Average number of sizes per order quantity (note 2)	1.1	1.2	1.2	1.2	1.3

NOTES

1 Steel specification, finishing process, and heat-treatments were as specified by each customer. Some high usage steel specifications were held in raw material stock at PSL either against known call-offs or in anticipation of future orders.

2 Most orders were only for one size, but a few were for up to four different sizes.

3 Call-offs or scheduled requirements (ie orders for a number of deliveries spread over several months) are treated in this analysis (and by the planning office and within manufacturing) as individual orders.

APPENDIX J.6

A REPRESENTATIVE SAMPLE OF ORDERS FOR UK ELECTRIC MOTOR AND FOR THE UK STOCKISTS STEEL MARKETS IN FEB 86

WORKS ORDER NUMBER	CATEGORY	TONNES ORDERED	KEY DATES - WEEK NUMBERS		
			works order raised	delivery required and acknowledged	delivery actual
M864	Electric Motor	10.0	5	12	11
M866		15.0	5	12	12
M878		8.0	5	12	12
M879		5.0	5	12	13
M880		10.0	5	12	9
M881		8.0	5	12	12
M910		6.5	6	13	16
M912		12.0	6	13	13
M913		12.0	6	13	13
M914		15.0	6	13	11
M930		8.0	7	13	14
M936		5.0	7	13	13
M937		10.0	7	13	15
M938		8.0	7	14	14
M939		8.0	7	14	13
S420	Stockist Steel	4.0	5	10	11
S426		4.0	5	10	11
S427		6.0	5	12	12
S428		5.0	5	12	11
S440		4.0	6	12	10
S441		10.0	6	12	12
S448		4.0	6	12	13
S449		4.0	6	12	11
S479		10.0	6	13	13
S480		4.0	6	13	13
S481		5.0	6	13	11
S503		5.0	7	14	14
S504		5.0	7	13	15
S505		3.0	7	13	13

Notes

1 A separate works order was raised for each size within a customer order.

2 Works order numbers M866, M879, M914 and M939 were also cold rolled.

APPENDIX J.7

A REPRESENTATIVE SAMPLE OF ORDERS FROM GAMBERT FABRIQUE IN FEB 86

WORKS ORDER NUMBER	DELIVERY TO	TONNES ORDERED	KEY DATES - WEEK NUMBERS: works order raised	KEY DATES - WEEK NUMBERS: delivery required and acknowledged	KEY DATES - WEEK NUMBERS: delivery actual
S463	France	10.0	6	13	12
S464	France	25.0	6	13	13
S465	France	25.0	6	13	10
S466	France	20.0	6	13	13
S467	France	16.0	6	13	9
S468	France	28.0	6	13	12
S469	France	35.0	6	13	13
S470	France	25.0	6	11	10
S471	France	20.0	6	11	12
S472	France	20.0	6	11	11
S473	France	15.0	6	11	13
S474	France	25.0	6	11	10
S475	France	10.0	6	11	11
S476	France	20.0	6	11	13
S477	France	20.0	6	11	11
S478	France	15.0	6	11	14
S416	UK	3.0	5	10	12
S417	UK	5.0	5	10	13
S418	UK	3.0	5	8	9
S419	UK	5.0	5	8	8
S492	UK	4.0	7	12	12
S493	UK	4.0	7	12	11
S494	UK	5.0	7	10	11
S412	Denmark	4.0	5	9	13
S413	Denmark	4.5	5	9	12
S414	Denmark	5.0	5	9	9
S415	Denmark	4.0	5	9	10
S489	Denmark	5.0	7	10	10
S490	Denmark	5.0	7	10	9
S491	Denmark	3.0	7	10	11

NOTES

1 A separate works order was raised for each size within a customer order.

2 Delivery promise for overseas destinations was acknowledged as the date the sections left PSL.

APPENDIX J.8

A REPRESENTATIVE SAMPLE OF UK ORDERS RECEIVED IN FEB 86 FOR CUSTOMISED SECTIONS (HOT ROLLED AND STANDARD FINISHING)

WORKS ORDER NUMBER	STEEL			KEY DATES - WEEK NUMBERS			TOTAL	
	standard	special	ORDERED TONNES	works order raised	delivery required & acknowledged	delivery actual	steel input	saleable output
C026	√		46.0	5	10	9	49.9	45.4
C052	√		7.5	5	10	11	8.0	7.3
C053		√	3.0	5	19	22	5.1	4.6
C057		√	6.0	5	20	20	7.9	6.4
C061	√		10.0	5	12	10	11.0	9.6
C082		√	8.5	5	19	20	8.7	6.9
C092		√	3.0	5	18	26	7.5*	2.2
C094		√	20.5	5	20	19	23.1	19.0
C099	√		52.0	5	11	10	58.0	53.3
C121	√		10.0	6	10	12	11.0	10.1
C126		√	10.0	6	22	21	13.0	11.1
C128	√		20.0	6	9	10	22.5	20.9
C132	√		75.0	6	12	12	83.5	77.1
C136	√		15.0	6	8	9	15.5	15.0
C150	√		20.0	7	12	14	22.5	19.4
C151		√	3.0	7	21	21	4.0	3.2
C152	√		15.0	7	12	11	17.0	15.3
C160		√	3.0	7	24	21	4.9	4.2
C167		√	10.0	7	26	29	22*	11.5
C169		√	3.0	7	21	21	3.8	3.4
C182	√		5.0	7	10	9	5.5	4.0
C186	√		3.0	7	12	14	3.5	3.2
C187		√	10.0	8	22	29	24.0*	12.5
C192		√	12.5	8	25	23	14.0	13.4
C193	√		3.0	8	12	12	3.5	2.6
C194		√	3.0	8	24	24	3.7	3.1
C204		√	3.0	8	26	32	4.2	2.5
C207		√	16.0	8	25	24	20.3	17.3
C222		√	4.0	8	20	22	4.0	2.6
C231	√		10.0	8	14	12	11.0	8.9

* Two separate rollings were necessary to achieve the required output (all or part of the first rolling was rejected by quality control).

Note: Works order numbers C052, C150 and C194 were also cold rolled.

APPENDIX J.9

A REPRESENTATIVE SAMPLE OF DELIVERIES FROM ENGLISH BILLETS PLC FOR STANDARD STEEL SPECIFICATION ORDERS

STEEL SPECI FICATION	BILLET SIZE mm	TONNES ORDERED	WEEK NUMBER DATE		
			ordered	required	received
PS 2000	100	250	25	36	44
PS 2000	120	105	25	36	34
PS 2000	130	85	25	36	38
PS 2000	150	80	25	36	35
PS 2000	190	130	25	36	34
PS 2000	250	270	25	36	32
XR 6	100	45	25	36	35
XR 7	110	45	27	37	38
XR 7	120	140	27	37	41
XR 7	140	150	27	37	40
XR 7	230	105	27	37	38
SA 270	70	55	27	37	38
SA 270	85	120	27	37	37
SA 270	100	80	27	37	34
SA 275x	70	40	27	37	42
SA 275x	100	20	27	37	41
SA 275x	120	20	27	37	40
PS 2000v	230	30	27	37	43
PS 2000x	250	35	27	37	41
PS 300	70	10	29	40	40
PS 300	100	40	29	40	38
PS 2000	70	115	29	40	42
PS 2000	85	60	30	40	42
PS 2000	170	40	30	40	43
PS 2000v	100	30	30	40	42
PS 2000v	120	35	30	40	40
XR 7	70	80	30	40	39
XR 7	85	90	30	40	41
XR 7	100	40	30	40	41

NOTES

1 English Billet Plc was PSL's principal raw material supplier.

2 A standard steel was classed as such by PSL if it had been processed previously, irrespective of the quantity used. This distinction from special steels signalled the fact that manufacturing would have processing experience of the material which would, in turn, lead to a reduction in problems and differences associated with one-off specials. Thus, actual process lead times were more in keeping with the norms used in lead time calculations.

3 Most (especially the high usage) standard steels were kept in stock by PSL at levels which related to annual usage. Orders on suppliers to replenish stocks were then made in the normal way based upon re-order levels.

APPENDIX J.10

REPRESENTATIVE SAMPLE OF DELIVERIES FROM ENGLISH BILLETS PLC FOR SPECIAL STEELS ORDERED FOR SPECIFIC JOBS

STEEL SPECIFICATION	BILLET SIZE mm	TONNES ORDERED	WEEK NUMBER DATE order	required	received	RECEIVED TONNAGE
5Y102	100	28	27	37	40	22.2
SD204	70	4	27	36	36	3.1
BS840	200	32	29	35	40	30.2
DX6DM	170	16	29	35	36	15.8
DN34B	85	4	29	39	36	4.2
DN36	140	32	29	35	39	31.9
Spec 2a	250	100	29	36	40	97.2
DN8	70	8	29	39	40	8.7
PS37	120	6	30	39	37	7.9
804/10	190	12	30	40	37	8.5
DL10	190	32	30	40	40	34.8
SA520	100	16	30	40	44	17.5
DL12	100	4	30	40	36	3.5
Spec 3b	250	16	30	40	38	14.9
DN8D	140	4	30	41	42	5.1
DN474	170	28	31	41	41	29.3
C2138	190	24	31	41	37	23.1
C2138	120	20	31	44	46	20.1
MK200	230	120	32	38	37	116.4
550B20	120	12	32	44	45	11.9
D142	210	4	32	42	40	3.7
820x	85	90	32	42	45	105.0
D1020	170	4	32	44	42	4.4
D1020	130	4	32	44	42	4.6
540C10	70	8	32	44	42	7.9
DN8D	210	16	33	44	45	15.5
DN36	100	4	33	44	43	4.4
SA862	100	4	33	44	43	2.8
DX6DM	210	16	33	44	40	19.6

NOTES

1 Special steels must be ordered in multiples of 4 tonnes up to 40 tonnes because of process restrictions (ingot sizes). The effective delivery tolerance on these orders is +/- 1 tonne.

2 English Billets Plc was PSL's principal raw material supplier.

APPENDIX J.11

ROLLING PROGRAMME - JUL 86

DATE (Jul 86)	BILLET SIZE - INPUT STEEL HEIGHT (MM)	
	MILL C	MILL D
1	250	70
2	150	70
3	150	70
4	140	70
8	140	70
9	110	85
10	110	85
11	120	85
14	130	100
15	130	100
16	130	100
17	190	100
18	140	100
21	140	100
22	150	70
23	150	70
24	170	70
25	170	120
28	250	120
29	230	120
30	210	85
31	110	85

APPENDIX J.12

REVIEW OF PSL'S MARKETS FOR 1975 AND 1985 IN TERMS OF TOTAL SALES (TONNES), MARKET SEGMENT CHANGES AND AVERAGE ORDER QUANTITIES (TONNES)

1 TOTAL SALES (TONNES) AND MARKET SEGMENT CHANGES 1975-1985

Market Segment	1975		1985	
	tonnes	% total	tonnes	% total
Electric Motors	79600	81	50400	50
Stockist Steel	15100	15	29700	30
Customised Sections	4200	4	20400	20
TOTAL	98900	100	100500	100

2 AVERAGE ORDER QUANTITY (TONNES) TRENDS 1975-1985

Year	Market Segment	% of total	Average order quantity (tonnes)
1975	Electric Motors	81	14.3
	Stockist Steel	15	4.9
	Customised Sections	4	16.6
1985	Electric Motors	50	7.3
	Stockist Steel	30	5.3
	Customised Sections	20	9.4

APPENDIX J.13

AN ANALYSIS OF DELIVERY PERFORMANCE IN PSL'S MARKETS

Market segment		total number of	Delivery performance				
			total	weeks of lateness			
				1	2	3	4+
Electric Motors		tonnes	140.5	13.0	10.0	6.5	-
		orders	15	2	1	1	-
Stockist Steel		tonnes	73.0	16.0	5.0	-	-
		orders	14	3	1	-	-
Gambert Fabrique	France	tonnes	329.0	20.0	35.0	15.0	-
		orders	16	1	2	1	-
	UK	tonnes	29.0	8.0	3.0	5.0	-
		orders	7	2	1	1	-
	Denmark	tonnes	30.5	7.0	-	4.5	4.0
		orders	7	2	-	1	1
Customised Sections	standard steel	tonnes	291.5	30.5	33.0	-	-
		order	14	3	3	-	-
	special steel	tonnes	118.5	8.5	-	17.0	16.0
		order	16	1	-	3	3
	total	tonnes	410.0	39.0	33.0	17.0	16.0
		orders	30	4	3	3	3
TOTAL		tonnes	1012.0	103.0	86.0	48.0	20.0
		orders	89	14	8	7	4

Note - Source Appendices J.6-J.8

APPENDIX J.14

RELEVANT ORDER-WINNERS AND QUALIFIERS FOR THE MARKETING STRATEGY INITIATIVES CONCERNING GAMBERT FABRIQUE AND CUSTOMISED SECTIONS

Order-winner and qualifying criteria	Gambert Fabrique*			Customised sections		
	1985	1986	1987	1985	1986	1987
Price	80	80	80	Q	Q	Q
Delivery - reliability	QQ	QQ	QQ	QQ	QQ	QQ
- speed	-	-	-	50	60	60
Quality	Q	Q	Q	20	10	Q
Existing supplier	20	20	20	10	10	20
Meeting new specifications	-	-	-	20	20	20

*Relates to the main contract with France

APPENDIX J.15

AN ANALYSIS OF THE CONTRIBUTION PER TONNE AND AS A PERCENTAGE OF INVOICED RATES FOR TYPICAL ORDERS IN FEB 86

Market	Size (mm)	Invoiced rates	variable costs	Contribution £s per tonne	Contribution invoiced rates%
		£5 per tonne			
Electric Motor XR7 (5 tonnes)	70	600	490	110	18
	110	500	411	89	18
	120	465	385	80	17
	140	420	350	70	17
	190	425	355	70	16
	250	430	360	70	16
UK Stockists (10 tonnes)	70	570	380	190	33
	100	490	316	174	36
	120	475	298	177	37
	140	465	280	185	40
	170	470	285	185	40
	250	450	290	160	36
GF (France) (20 tonnes)	85	420	365	55	13
	110	340	306	34	10
	130	320	290	30	9
	150	300	275	25	8
	190	300	280	20	7
	250	300	285	15	5
GF (UK) (5 tonnes)	85	480	410	70	15
	110	390	336	54	14
	130	360	314	46	13
	150	350	290	60	17
	190	340	295	45	13
	250	330	300	30	9
Customised Section MK200 (10 tonnes)	85	810	600	210	26
	120	680	500	180	26
	190	610	470	140	23
	210	610	470	140	23

NOTES

1 The variable costs included in these calculations have been chosen to reflect the order quantities which prevail in these markets.

2 Source - Appendices J.3 and J.4

APPENDIX J.16

ANALYSIS OF MARKETS IN TERMS OF ORDER QUANTITIES

Attachment source	Market Segment		Average order quantity (tonnes) per size - 1985
1	Electric Motors		7.3
2	Stockist Steels	overall	5.3
		excluding Gambert Fabrique France	4.2
3	Gambert Fabrique	France	19.7
		UK	3.9
		Denmark	3.9
		Overall	11.6
4	Customised Sections		9.4

Notes 1 Stockist Steels, excluding Gambert Fabrique (France)

		Tonnes
Stockist Steels overall		
- total sales		29700
- average order quantity per size (tonnes)		5.3
Gambert Fabrique (France)		
- total sales (12 monthly orders averaging 670 tonnes)	8040	
- % of total sales		27
- average order quantity per size (670 tonnes + 34 sizes - see Note 3, Attachment 2)		19.7
Overall less Gambert Fabrique (France)		
- total sales (29700 - 8040)		21660
- % of 1985 total sales (100 - 27)		73
- average order quantity per size		4.2

2 Gambert Fabrique - average order quantities

- France - average monthly order = 670 tonnes
  - average size = 34
  - = average order size = 670 + 34 = 19.7 tonnes

- UK and Denmark
  - average monthly order = 35 tonnes
  - average size = 9
  - = average order size = 35 + P = 3.9

- overall - average monthly order = 670 + 140 (35 x 2 x 2)*
  - average size = 34 + (9 x 2 x 2)
  - = average order size = 810 + 70 = 11.6

* ie Both UK and Denmark order twice per month whereas France only orders once per month

APPENDIX J.17

DELIVERY SPEED AS AN ELEMENT OF GF (UK) AND GF (DENMARK) ORDERS

Appendix J.7 gave details of Gambert Fabrique orders. As this was part of the overall Stockist Steel market, then this 5 week process lead time again prevailed. An analyis of the gap between raising a works order and the acknowledged and required delivery week showed a 5 to 7 weeks gap for GF (France) but a very different position for GF (UK) and GF (Denmark), as illustrated below:

Customer	Number of orders with gap of (weeks)			Total
	3	4	5	
GF (UK)	3	-	4	7
GF (Denmark)	3	4	-	7
Total	6	4	4	14

Therefore, 10 out of 14 of these orders had a gap which was less than that required by the process lead time norms. Delivery speed was now an issue

APPENDIX J.18

AN ANALYSIS OF CUSTOMISED SECTIONS BY 'MANUFACTURING SEGMENT' IN TERMS OF DELIVERY PERFORMANCE

	Category	Number of orders	Total tonnes ordered	Delivery performance - number of orders								
				on time	number of weeks late							
					1	2	3	4	5	6	7	8
A	Standard Steels - delivery speed is not an order-winner	9	218.5	6	1	2	-	-	-	-	-	-
B	Standard steels - delivery speed is an order-winner	5	43.0	2	2	1	-	-	-	-	-	-
C	Special steels - delivery speed is not an order-winner	9	85.0	7	-	-	1*	-	-	1ø	-	-
D	Special steels - delivery speed is an order-winner	7	34.5	2	1	1	1	-	-	-	1*	1*
	Total	30	381.0	17	4	4	2	-	-	1	1	1

* Processing problems as explained in the Note to Appendix J.8.

ø Low yield (60%) although still within the +/- 1 tonne convention - could equate to process problems which would account for the delays besides the low yield.

Note - source Appendix J.8.

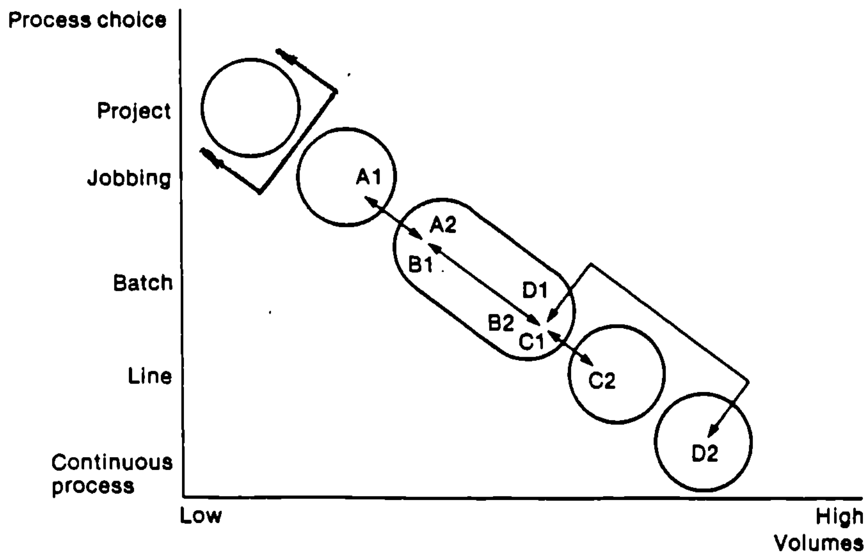
5 PRODUCT PROFILING

Trade-offs in process choice and the increasing recognition of these was carefully explained in Chapter 3. At this time, the link between these methodological developments and product profiling was stated but not explained. Therefore, before examining the evolution of product profiling it is important to provide essential background against which these developments should be set as part of the overall business context into which these need to be placed, and to establish essential linkage to the methodology developments detailed earlier.

5.1 PROCESS INVESTMENTS : RESTRICTIONS AND REALISM

A company needs to have a comprehensive understanding of the changing implications to its business as alternative processes are chosen, then use this concept as a key input into the corporate strategy debate. Chapter 3 described the implications of process choice and contained details of two important developments which were outcomes of the research (see pp81-84). The first concerned the trade-offs associated with process choice, a factor already highlighted at the beginning of this chapter. Linked to this is the fact that several researchers in their explanations of processes singularly failed to clearly distinguish between the classic forms of process (Hayes and Wheelwright, 1984; Cohen and Lee, 1985 and Fine and Hax, 1985). The result was that attempts to apply business/products to processes were fundamentally inaccurate and the resulting obervations were flawed. The second concerned the fact that companies rarely make a series of investments which are tantamount to the process life cycle phenomenon put forward by Hayes and Wheelwright (1979). In this classic article they argued that there is a need to link together product and process life cycles in order to achieve an appropriate level of fit between these two dimensions of a business.

Understandably, however, companies do not make (or wish to make) a series of investments which reflect the volume growth associated with typical product life cycles. Instead, they choose investments which reflect the anticipated sales forecasts and associated volume levels in order to avoid making a series of investments as volumes change. This is as much to do with lead times associated with process investments as it is to do with the fact that multiple investments are simply too expensive. Furthermore, as explained in Chapter 3, the choice of project and continuous processing is also linked to fundamental characteristics of the product. A project process tends only to be chosen where the product cannot be moved, while continuous processing can only be used with products that are easily transferred from one part of the process to another (eg fluids, chemicals and foodstuffs - see p110. Figure 5.1 attempts to illustrate these dimensions. It first of all shows that project has no viable link with the other alternatives as explained earlier.



⟷ This shows four potential volume transitions which typically may face a business. The first example shows a move from one-off, *low-volume (A1) to repeat order, low-volume demand (A2) for a product of vice versa and the change in manufacturing process which should ideally accompany this movement. Examples B1 to B2, C1 to C2 and D1 to D2 show similar demand changes at different points on the volume scale and requiring similar decisions concerning the realignment of the process choice.

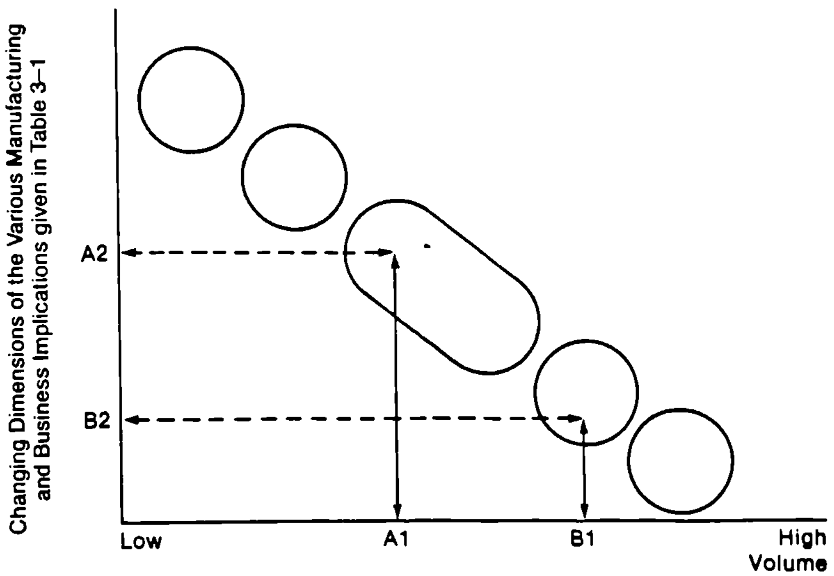
*One-off is a description of uniqueness, not order quantity.

Figure 5.1 An illustration of the restrictions and realistic phases of process investments (Hill, 1985, p81 and Hill, 1989, p73)

Secondly, any additional alternative process choice investments in manufacturing, not to make a different product but to reflect changes in volume would normally be limited (see Figure 5.1) to A1 and A2 (jobbing to low volume batch), B1 to B2 (low volume batch to high volume batch) and C1 and C2 (high volume batch to line). In addition, where volumes decline in continuous processing situations then these plants are run on the basis of what is known as campaigning - 3 months running and 3 months stopped (say) as shown by D2 to D1.

5.2 PROCESS CHOICE AND ASSOCIATED INVESTMENTS

Fundamentally, therefore, companies make an investment associated with a level of volume - often, and understandably, reflecting the company's view of the forecast sales. What they often fail to appreciate is that when they choose a process (including one of the many hybrids available) then they also choose the set of business trade-offs associated with that choice, as illustrated in Figure 5.2



⟵⟶ Phase 1 which links the market/volume to the process choice.

⟵ - - - ⟶ Phase 2 which picks up the corresponding manufacturing and business implications of the many dimensions which go on the vertical axis (see pp 84-88). The above diagram shows volumes A1 and B, the appropriate process choice and their corresponding points on the manufacturing and business implications dimensions A2 and B2

Figure 5.2 Selecting a process based on volumes and the associated trade-offs involved (Hill, 1985, p68 and Hill, 1989, p62)

However, there is also another factor overlooked by many businesses - the realisation that whereas investments in manufacturing are inherently fixed, the markets they serve are not. Thus, although market needs change, the ability of process and infrastructure investments to support these changes will not be maintained unless there is a deliberate set of decisions to do so.

Assessing how well existing processes fit an organisation's current product requirements, and making appropriate choices of process to meet future products, and their associated volumes and order winning/qualifying criteria are critical manufacturing responsibilities, owing to the high investment associated with the outcomes of these decisions.

However, as explained earlier, when companies buy processes they often fail to appreciate the business trade-offs embodied in those investments. The concept of product profiling offers the opportunity for a company to test the current or anticipated degree of fit between the characteristics of its market(s) and the characteristics of its existing or proposed processes and infrastructure investments (the components of manufacturing strategy - see Figures 3.2 and 3.3). The purpose of this assessment is twofold. First, it provides a way to evaluate and, where necessary, improve the degree of fit between the way in which a company wins orders in its markets, and manufacturing's ability to support these criteria (ie, manufacturing's strategic response within a business). The second is to help a company to move away from classic strategy building, characterised by functional perspectives being agreed separately, without adequate attempts to test the fit or reconcile differences in terms of what is best for the business as a whole.

In many instances though, companies will be unable or unwilling to provide the degree of fit desired, due to the level of investment, executive energy, and time scales involved. But sound strategy concerns not getting the answers right, but improving the level of consciousness a company brings to bear on its corporate decisions. In such circumstances, however, product profiling will increase corporate awareness, and allow a conscious choice between alternatives. It is this level of strategic alertness to which companies have not aspired in the past.

5.3 THE NEED TO EXPAND THE LANGUAGE BASE IN THE FIELD OF MANUFACTURING STRATEGY

Part of manufacturing's difficulty has been to find ways to express important perspectives in a manner that provides for corporate debate and discussion. Unless it can do this, then other business functions will find difficulty in embracing the issues on hand and, in turn, being party to their resolution. Intutition, experience and gut-feel must give way to business-related concepts and explanations.

Each business will require its own approach and resolution. The examples described in the following sections met the specific needs of those businesses to which they relate. In no way is it intended that they should be considered as universally applicable. However, it is the conceptual base on which these analyses rest that can be transferred and used to prepare similar analyses, where appropriate, for other businesses.

5.4 PRODUCT PROFILING

Inconsistency between the market and manufactuirng process capability, in terms of supporting the business specification of its products, can be induced by changes in the market or process investments, or a combination of the two. In all instances, the mismatch is created by the fact that the investments within manufacturing are both significant and fixed in nature (once a company has purchased them, then it will have to live with them for better or for worse for many years to come). On the other hand, corporate marketing decisions can often be relatively transient in nature, should a company so decide. While this allows for change and repositioning, manufacturing decisions bind the business for years ahead. Thus, linkage between these two parts of a business is not just a felt need, but a reality requiring strategic awareness, recognition, and action.

Product profiling is a way to ascertain the degree of fit between the choices of process, which have been or are proposed to be made, and the order-winning criteria of the product(s) under review. The sections that follow describe research undertaken by myself. The applications have been chosen to illustrate three different causes of manufacturing strategy/market mismatch which the product profiling approach was able to illustrate and amplify.

In all three illustrations, the approach increased each firm's understanding of the basic issues involved to the extent that it enabled them to change or reshape their strategic direction. For one company, the outcomes provided essential insights into why it should not proceed with a proposed investment. For the other two applications, the approach highlighted the principal cause of a poor overall performance in all or part of the business. Based on these insights, each company was then able to take the necessary corrective action.

5.41 THE PROCEDURE ADOPTED IN PRODUCT PROFILING

The concept of product profiling helps to draw corporate attention to mismatches similar to those briefly mentioned above and which will form the core of the three sections which follow. The methodology graphically represents key marketing and manufacturing differences the cause of which will differ.

As stated earlier, the concept of product profiling is based upon a recognition of the trade-offs associated with process choice. In particular, it is often most marked in its application within the choiced of batch processes. As shown in Figure 3.11, the range of volumes which batch supports is very wide from the low volumes similar to those in jobbing to high volumes similar to those in line.

The processes within the three illustrations which follow are all batch. That is, a process is set up and the required quantity is produced. The process is then stopped and reset for the next period.

Within this context, the steps to be followed in profiling products onto processes is as follows-

1 Select relevant aspects of product/markets, manufacturing, investment and cost and infrastructure. The dimensions should reflect the key issues involved. However, it is most important in this phase to keep the number of dimensions to a minimum. Choosing too many will confuse. The key is to keep the choice small so that the profile which follows will be clear. Typical choices are provided in the three examples of product profiling given later in this chapter.

2 Display the characteristics of process choice that would be typical for each chosen dimension. This provides the backdrop against which the product or products are profiled.

3 Profile a product (or group of similar products) by positioning it on each of the implications selected, to test the level of correlation between the market needs and manufacturing's current or proposed response to their provision.

The resulting profile illustrates the degree of consistency between the characteristics of the market and the business specification of the process and chosen features of investment, cost and infrastructure. The more consistency that exists, the straighter the profile will be. Inconsistencies between the market and manufacturing's inherent ability to meet the product performance criteria (order-winning and qualifying criteria) will show in the dog-leg shape that will result.

5.42 INDUCING MISMATCH WITH PROCESS INVESTMENTS : ONTARIO PACKAGING

As emphasised in the last chapter, when companies invest in processes they buy a set of business trade-offs, fixed in nature. Thus, if a company invested in a process that embodied a set of trade-offs inconsistent with its markets, then, unless it intended to change its markets, it would induce inconsistency, corresponding to the level of mismatch between process and market, the relative size and importance of the process(es) involved, and the associated level of reinvestment.

An example of a mismatch induced in this way is provided by the first company I researched, Ontario Packaging* which was part of Texet Industries*, a large group of companies based in Canada but with plants in Europe and the USA and with diverse interests in food, cosmetics, engineering and toys, besides a growing stake in retail holdings and other non-manufacturing businesses. Taken over in 1984, Ontario Packaging was now one of several packaging companies within the Group but the first within the Province.

Having given the company time to settle down within the new corporate structure and allowed the newly appointed managing director to gain an

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*Both names have been disguised

understanding of the business since his transfer from within the Group some twelve months before, the Executive Group of Texet had recently asked the company to review its position. The review was to include an assessment of its current markets and to include any process investment proposals it thought to be necessary in the future, with an indication of why they should take place and the anticipated impact on the business as a whole and on the various return on investment measures used within the Group, in particular.

5.421 Manufacturing

Ontario Packaging produced a wide range of cartons and other forms of packaging. Its manufacturing capability comprised various forms of printing, laminating, cutting, creasing, glueing and other auxilliary processes, together with a whole range of in-house support functions.

As part of a strategy to up-grade its processes (as well as increase its process capability where appropriate) Ontario Packaging proposed to invest in a state-of-the-art laminating process, which would replace its existing capacity. At the time of the research, some 30% of total production volumes (standard machine hours) were laminated.

At a cost of Canadian $2.5 million, the new laminator would offer significant savings in direct labour (through reduced manning), lower material costs within the laminating process and a lower maintenance bill (with, however, a corresponding increase in depreciation costs).

However, in order to achieve the group payback norm of 4 years, the company would need to increase its sales of laminated products by about 40% on current levels. It was this higher volume on which the savings to be made with the investment proposal had been based.

The order quantities currently processed averaged about 7 hours and ranged from 2 to 60 hours. Whilst set-up (or make-ready) times for the new process were similar to the existing equipment, throughput speeds were more than twice as fast. Besides the basic gains accruing from the increase in throughput speed and the reduced material wastage mentioned earlier, the new process would offer few additional technical advantages other than improving on the current, reduced performance of existing processes which were a result of wear and tear with age.

Due to the space restrictions and to maintain the current, sensible flow of materials through the manufacturing process, it was intended to install the proposed new process where the existing equipment was positioned. The existing equipment comprised two machines and was run on a two-shift basis. It was also proposed to run the single replacement process on a two-shift basis.

Whilst the utilisation of the current process was less than 60%, the target set in the proposal for the new investment was 80-85% based on higher volumes and the reduction from two to one laminating machines.

5.422 Marketing

Over the years, a consistent marketing strategy had enabled the company to increasingly position itself in the higher quality end of all its markets. The current laminating facility was able to meet the technical features of the final carton although it was recognised that the process under review would enable production to meet these demands more easily.

A marketing survey on the relative importance of different purchasing criteria to carton users was taken at the time of the research. It revealed that in the segment to which this investment proposal related, providing prompt quotations and samples, together with high delivery reliability and a willingness to meet schedule changes were critical features and ones which Ontario Packaging had proved to be better at providing than its competitors.

Discussion on how the company won orders for its current work and the anticipated order winners for the new work (the 40% uplift in sales referred to earlier) revealed a significant change. Whilst price was not an important factor in winning current orders for these products, it would increasingly be so for the new orders which the company would need to secure in order to achieve the additional volume called for by the throughput levels underpinning the process investment proposals being considered.

Current sales were split roughly half-and-half between those which were not price sensitive and those where price was an order-winning criterion at some level. However, the latter orders varied in their degree of price sensitivity. For two-thirds of this segment, price had been given a weighting of 20 points or less.

It was recognised that the proposed increase in sales of laminated products of about 40% of current levels would be achieved in segments where price would increasingly be the most important order-winner. The company, although recognising that this would require significant sales effort, had already identified the segments and customers which were available and considered the achievement of these higher volumes to be a realistic target within the required timescales. The company also emphasised the fact that to compensate for the increased price sensitivity of the new business, it would be undertaking to process orders which comprised much higher volumes, a factor which was seen to reinforce the throughput speed gains inherent in the new process in terms of the cost savings available.

5.423 Manufacturing strategy review

An overview of the company's markets highlighted particular features

- In the past the company had moved its market position to the higher quality segments. In addition, the marketing survey had revealed key features which were important in these markets
  - prompt quotations and samples
  - delivery reliability performance
  - a willingness to meet schedule changes (ie delivery speed)

  Finally, price was not an important factor in winning current orders

- For laminated products, which accounted for 30% of current production volumes (standard machine hours) price had an order-winner weighting of more than 20 points for only 17% of the products using the laminating process. In general, however, current laminated products had similar product characteristics to those above.

To meet Texet's minimum payback norms, the company would have to increase sales revenue by 40%. This would signal a distinct market change as all the new business would be price sensitive.

For manufacturing to meet the low cost requirements of the proposed price sensitive markets the following conditions would need to be provided

- relatively high volume orders
- steady schedules in terms of planned production and the product specification
- delivery reliability would need to be maintained

5.424 Manufacturing strategy issues

The important implication of this proposal was that it would result in the rapid introduction of price sensitive products within the context of a current marketing strategy which is based on other order-winners.

The price sensitive content of the future sales would be as high as 40% of laminated produts which equates to 12% of all products. The result would be the introduction of an ambivalent situation for manufacturing in terms of its main task. On the one hand it would need to be provided with the conditions in which to achieve low costs (viz large volumes, fast throughput times and fixed schedules/call-offs), while on the other it would need to meet customer schedule change requirements. In addition, the process throughput improvements which the new laminator would offer resulted in average production run lengths being approximately halved (from 7.0 to 3.5 hours) with some reduced to as short as one hour.

The need to increase the utilisation of laminating capacity to 80-85% would also reduce the opportunity for Ontario Packaging to meet customer-induced changes without incurring costs and loss of available machine time. Such high levels of utilisation would increase the need to change schedules as available "spare capacity" would be significantly lower, all products would now go through one rather than the existing two laminating machines and the "new" business would tend to be higher volumes with correspondingly longer run lengths. Hence, breaking into schedules would happen more often.

The suggested investment coupled with the need to increase sales in the price sensitive segment of its laminated product markets would, therefore, bring a substantial conflict in terms of manufacturing's task. The difficulty faced by manufacturing was how to explain this in a way to which other functions in the business could relate.

5.425 The outcome of product profiling

A way of explaining the difficulties faced by manufacturing in a way such that other functions in Ontario Packaging would relate is provided by product profiling. The approach facilitates the explanation of the manufacturing implications of these corporate choices in a way which will enable the business to debate all the outcomes and arrive at a decision which would be best for the company as a whole.

Using the methodology outlined in section 5.4 Figures 5.3 and 5.4 illustrate the outcome of such profiling to reflect the position at Ontario Packaging described here. Figure 5.3 showed the then current position. Figure 5.4 showed the position which would follow the proposed laminating investment. This offered the company the chance to clearly see that manufacturing could not support the characteristics of what would be two different markets. The straight line (or matched) relationship between markets and manufacturing which results in Figure 5.3 has been replaced by the dog-leg (or mismatched) relationship associated with the proposed investment.

Presented with this graphic illustration of the potential outcome for the business of going ahead with the investment proposal, the directors of the company were given a medium for debating some of the key issues involved. One significant feature was that it enabled the discussion to link markets to manufacturing and in this way created strategic insights based on business rather than functional perspectives. Recognising the coherent arguments provided by the manufacturing function's strategic statement, the company decided against the process investment proposals. Instead, it refurbished its existing laminators thereby improving the quality of its processes without incurring the mismatch which the alternative action would induce.

Some relevant aspects			Typical characteristics of process choice		
			jobbing	batch	line
Products and markets	product	type	specials		standards
		range	wide		narrow
	customer order size		low		high
	level of schedule changes required		high		low
	order-winner(s)		prompt samples/ delivery speed		price
Manu-facturing	process	technology	general-purpose		dedicated
		flexibility	high		low
	predominant utilization		labor		plant
	production volumes		low		high
	Key manufacturing task(s)		delivery speed: schedules & pre-customer order demands		low cost manufacturing

○ Position on each dimension of the current products and the resulting profile ———

Figure 5.3 A product profile illustrating the current position

Some relevant aspects			Typical characteristics of process choice		
			jobbing	batch	line
Products and markets	product	type	specials		standards
		range	wide		narrow
	customer order size		low		high
	level of schedule changes required		high		low
	order-winner(s)		prompt samples/ delivery speed		price
Manu-facturing	process	technology	general-purpose		dedicated
		flexibility	high		low
	predominant utilization		labor		plant
	production volumes		low		high
	Key manufacturing task(s)		delivery speed: schedules & pre-customer order demands		low cost manu-facturing

Position on each dimension of the current products and the resulting profile ———

Position on each dimension of the new products and the resulting profile ---------

Note the position of the profile on 'process technology' is unaltered as even with the new laminator the majority of processes would be the same

Figure 5.4 profile of the two sets of products showing the distinctly different requirements

5.43 APPLYING THE SAME MANUFACTURING STRATEGY TO TWO DIFFERENT MARKETS : HOFFMAN TOBACCO

The last research example concerned the impact on the fit between a company's market and its manufacturing capability brought about by investments in a significant part of its process. Without a well-developed manufacturing strategy the company was unconsciously driven by other functional (in this instance, finance) norms and arguments into an inappropriate, major investment. Failure to recognise that investment decisions need to be based on strategy and not functional perspectives and prerequisities, is a common contributor to poor corporate performance.

However, an equally important source of inappropriate investment decisions is derived from assuming that to meet different corporate requirements a similar manufacturing strategy approach can be applied. Typically, this happens where specialists' views form the basis of initiatives, rather than a manufacturing strategy formulated to the requirements of individual markets. To help explain these differences, product profiling can again provide a graphic description of the resulting mismatch. The example which follows is based on my research work undertaken in the second half of the 1980s.

Hoffmann Tobacco* was a wholly-owned subsidiary of Teison Industries Inc*, a North American holding company with interests in papermaking, printing and textiles besides the tobacco industry. With its head office based in Virginia (USA), the Teison Group had subsidiaries throughout North America, Europe and Australasia. Hoffmann Tobacco, as with other subsidiaries in the Teison Group, had a high degree of autonomy in terms of its corporate control and direction. It had two manufacturing plants within the UK which produced cigarettes for both the home and overseas markets.

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*Both names have been disguised

While imported cigarettes would have some appeal in overseas markets it was recognised that they would inevitably lose out to other brands (particularly local products) on the basis of price. In addition, a climate of falling demand for cigarettes in the UK and other traditional markets added to the pressure for the company to offer a wider range of products and also to reduce costs wherever possible.

5.431 Marketing

Due to the growing recognition of the harmful effects of smoking on a person's health, the level of cigarette sales in many countries had fallen appreciably. The tobacco industry had, therefore, been forced to rethink its strategy in order to adjust for the loss of sales revenue and profit which had resulted.

In addition, the move from shorts to king size cigarettes, the introduction of cut- price cigarettes from R J Reynolds, Philip Morris, manufacturers in West Germany and own brand-labels (eg Victoria Wine and Spa Grocers) added to the pressures for additional investment to meet new brand requirements and essential reductions in cost.

The company's marketing strategy was to increase its share of the home market (in an attempt to maintain current domestic sales revenue in what was recognised to be a declining market) while increasing the total value of exports abroad. The principal target areas for growth in export sales were the Middle East, West Africa and the European Duty Free segments.

In broad terms, the company's marketing strategy had four principal features:

- advertising - to target those segments of the market in which people currently smoked and for whom smoking had some appeal while emphasising those features of the product which gave the most actual or perceived benefit.

- product quality - to ensure that the product was manufactured and presented at the highest level of quality in terms of tobacco blend, feel and look of the cigarette itself and packaging as a way of maintaining its position.

- price - the decline in sales had resulted in surplus manufacturing capacity within the UK cigarette industry as a whole which, together with the low-priced European cigarette imports mentioned earlier, had placed significant emphasis on the need for cost reduction.

- product range - in response to the fact that while cigarettes were bought for many reasons, one of those clearly identified was image. Although this was in part related to product quality, the need to offer a wide range of products was a most important way of increasing both Hoffman Tobacco's share of the UK market and sales in current and future export markets.

One further feature of the UK market also emphasised many of the changes taking place. The continued growth in sales to multiple retailers (eg Tesco and Sainsbury) at the expense of the small retail outlets meant an increasing squeeze on prices similar to that which these retailers had successfully applied to food and other products in the past. This factor further emphasised the need to reduce costs in order for the company to remain competitive within its markets.

In overall terms, Hoffman Tobacco has fared much better that most of its competitors. Imperial Tobacco, Rothmans and BAT had all been forced to reduce capacity in the mid to late 1980s. Imperial had closed sites in Bristol, Nottingham and Glasgow with a loss of 1700 jobs, Rothmans had shut its Basildon plant with 1200 job losses and BAT had closed its Liverpool unit with its associated 1800 jobs. During this period, the company had been able to increase market share of UK cigarette sales while increasing exports in both existing and new areas. However, much of this had been due to having the best brands in the market. In addition, overall corporate performance had been enhanced by sales of cigars and tobacco for pipe and "roll-your-own" sales.

5.432 Manufacturing

One part of the total response to declining cigarette sales and increasing competition had been a productivity improvement drive in the key manufacturing areas. In this context the company and the Tobacco Workers Union (TWU) agreed a whole series of changes which needed both worker cooperation and substantial capital investment. The aim of the programme was to help the company survive in a competitive market while maintaining real corporate earnings, especially in future years. The changes were a combination of restructuring, process investments and changes in working methods and manning levels and were to be introduced at both the Norwich and Edinburgh* plants.

• Restructuring

In the context of declining sales for cigarettes, the need to improve the links between the marketing and production functions was well appreciated. The

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*The locations have been disguised

previous structure had formalised the separation of these two parts of the business and was recognised to be an important cause of liaison, communication and coordination problems.

In order to improve these important links within the business, a policy decision was taken to allocate certain products to be made at each plant in such a way as to achieve greater product identity within the business as a whole. This orientation also needed to reflect the capacity requirements at each plant and was undertaken over a period of three years as shown in Appendix K.1. When completed, it was agreed by all the principal functions concerned to have brought a significant improvement to the working relations particularly between the marketing and production functions.

- Process investment

Multi-functional task forces were established in both plants to undertake a review of the manufacturing and distribution activities. Their broad terms of reference were to recommend the best process mix, manning levels and working practices to achieve the required production levels with associated lower costs. Considerable work was undertaken to identify the technical suitability of available processes which incorporated the latest designs and controls and offered significant improvements in terms of throughput speeds.

The principal investment proposals concerned the secondary stage* of the manufacturing process which involved the making and packing of the cigarettes themselves. The throughput speeds of cigarette making and packing machines had increased considerably since the late 1960s. The new generation of Protos could now run at making speeds of 8,000 cigarettes per

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*The primary stage was concerned with preparation and blending which were completed prior to the secondary stages minute (cpm) compared to the current Molins makers which worked at speeds of 5,000 cpm. In addition, the Molins HLP4 and the GD packers gave corresponding uplifts in throughput speeds. Finally, the proposals also called for the introduction of a conveyor/reservoir system with elevator arrangements which were designed to link a maker and packer together. With reservoir capacity giving storage space for in excess of 50,000 cigarettes, the system comprised an automatically controlled conveyor which linked the two parts of the process together. As cigarette makers have much higher throughput speeds than packers, the basic concept of linking one maker to one packer could be extended by additional conveyors enabling the linking together of machines of different speeds in order to acheive desired levels of matching and the resulting improved overall use of the capital investments.

The proposed process investments centred around the provision of two major savings

- high-speed makers and packers which would reduce the number of machines required for a given production volume and hence reduce the direct operator, indirect support and overhead requirement throughout

- secondary process investments to allow further reductions in direct and indirect employees by mechanising certain tasks and reducing the manning levels involved in taking part-finished products from one process stage to the next

Appendix K.2 summarises the present product mix characteristics at both plants while Appendices K.3 and K.4 list the current secondary equipment in use at Edinburgh and Norwich, the advantages to be gained and the anticipated reduction in costs.

5.433 Current position

By involving the employees and trade union representatives at an early stage and continuing this high level of involvement throughout, the necessary reorganisation and manpower reductions which had ensued were completed without any signs of animosity or disagreement from those involved. The overt and genuine wish to involve those concerned in the rationale for the proposed changes was built on many years of increasing openness displayed within the Company. The result was that the relatively complex sets of arrangements were duly completed on time and the expected reductions in the 500 strong, factory-based staff were achieved.

However, although the planned labour reduction had been accomplished within the set time scales, the anticipated profit improvements had only been achieved at the Edinburgh plant. Given the similarity of investments made and the gains in labour cost reductions which accrued, it was difficult, at least from a distance, to understand the success of one application and the relative failure of the other. At the time of the research, current results confirmed the significant disparity between the two plants. After discussions, initiatives and promises, the Norwich plant's performance was still well short of target. This was in marked contrast to the Edinburgh plant which seemed to go from strength to strength. The reasons for this difference were not at all apparent. In fact, the similarity of investments and approaches undertaken at each site made comparisons the easier to make and contrasts the easier to conclude. The problem was to identify the fundamental nature of this difference which was marked in itself and difficult to understand given the circumstances involved.

Part of an in-depth review of the reasons behind this underpeformance provided some additional insights. Over the three years prior to the research, the market had changed. Customer lead times were much shorter and as many of the products were now customised at least in terms of packing there was increased pressure on meeting agreed delivery dates, particularly so in export markets and the lower volume end of the company's business. Ideally, manufacturing needed between 3 and 5 weeks to meet a delivery depending upon the degree of customisation involved. As higher volume items were normally met from finished goods inventory, the total lead times estimated above* were for customised products, including larger volume orders of an infrequent nature from some overseas countries. A review revealed that about 65 percent of all orders received were for delivery in less than 5 weeks while almost 35 percent were for less than 3 weeks. This pattern was increasingly common throughout the whole of the company's business. In addition, whereas overall sales (both in terms of revenue (£s) and number of cigarettes sold) had slightly increased, since the decision to orientate different products to the two plants the order size for the products had, if anything, declined. About half the orders received were for 100,000 cigarettes or less with over 75% for upto 500,000. Although many of these were for the company's higher volume products and were, therefore, cumulated within the production scheduling system, there were also those products which experienced a more intermittent pattern of demand as would be anticipated with lower volume products. Certainly this mix of work embodied a wider range and spread of volumes than before, particularly at Norwich.

The review also revealed that the new equipment at the Norwich plant had experienced some problems (see Appendix K.5). The new plant had resulted in reducing the capacity requirements (and subsequent manning levels), the work-in-progress inventory and associated indirect

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*The lead times of 3 to 5 weeks quoted here comprised material lead time plus process lead time.

labour at both plants. The problem was how to improve the performance at Norwich up to plan and on a par with that being achieved at Edinburgh.

The decision to provide orientation to its business, in terms of products, manufacture and markets resulted in a distinct orientation in each plant of products and associated volumes. An analysis of the collected data in Appendices K.1 and K.2 showed an enormous difference in terms of cigarettes made at each plant

	Edinburgh	Norwich
Used in a typical month		
• brand types	3	25
• packaging	1	15
• product codes	65	560
Total brand types	3	27

The spread in volumes across these product types (as shown in Appendix K.1) also reflects this relatively high volume nature of the products manufactured in Edinburgh and the lower volume nature at the Norwich plant. As the plant review above revealed, of the Edinburgh-manufactured brands, 93% were for Virginia Mild, even though these had different packaging requirements - see Appendix K.1 for the mix of work at both plants.

Although the orientation of product types had an accepted strategic value, the problems facing Norwich came from the manufacturing investments made. The company, assuming similar market characteristics embarked on similar manufacturing strategies. The data shows how different the tasks were, especially given the increasingly shorter lead times experienced and the fact that Norwich (compared to Edinburgh) was less able to supply orders from finished goods inventory.

The decision to link together batch processes creates a hybrid which is more towards the characteristics of line and the change in trade-offs which result (see Figure 5.5). The ensuing mismatch between the manufacturing strategy decision and the Norwich requirement (illustrated in part by the downtime analysis given in Appendix K.5) is in sharp contrast to the matched nature within the Edinburgh plant.

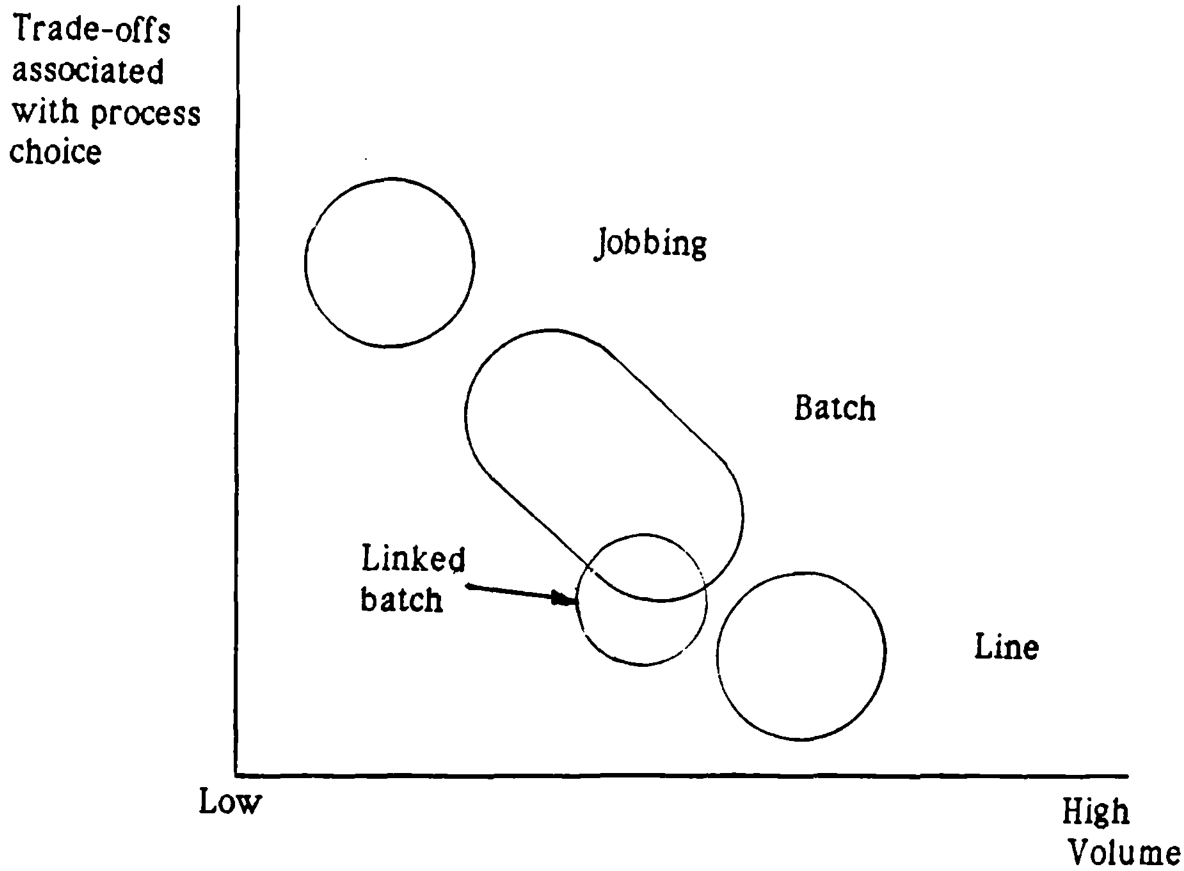
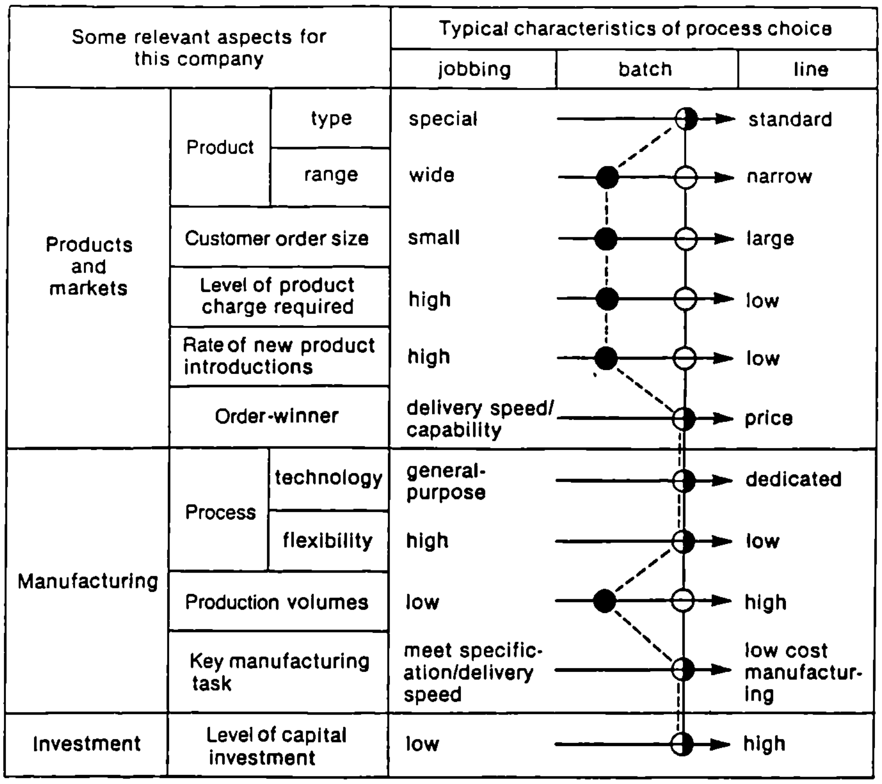


Figure 5.5 Linked batch process in relation to batch illustrating the higher volume related nature of this process choice compared to classic batch processes

The need in strategy to explain the cause of problems was facilitated in this situation by the use of product profiling. The resulting profiles (see Figure 5.6) clearly demonstrate the mismatch at Norwich, which is a fundamental reason for this plant's poor performance. On the other hand, the matched profile of Edinburgh underpins its favourable results. The use of product profiling in this situation offered the opportunity to illustrate the fundamental cause of the wide discrepancies in performance of two plants in which similar manufacturing strategies had been followed. For Edinburgh, the decisions were in line with its market needs whereas in Norwich, they were out of line as the characteristics of its markets were fundamentally different to those of the Edinburgh plant and, therefore, required a different strategic response to meet the low volume, wide product range and short lead time needs of its customers.

Figure 5.6 illustrated how these changes in manufacturing fitted Edinburgh's markets, while they led to a significant mismatch for Norwich. The procedure followed was similar to the one outlined in Section 5.41. Again, the first step was to describe, in conceptual terms, the characteristics of product/markets, manufacturing, investment/cost, and infrastructure features pertinent to the business. The dimensions selected for these two plants are detailed in Figure 5.6. First, the characteristics that reflect the change between jobbing, batch and line need to be described. Thus, the product range associated with jobbing is wide, and becomes increasingly narrow as it moves through to line. Whereas, customer order size is small in jobbing, and becomes increasingly larger as it moves though to line, and so on. These dimensions represent the classic characteristics of the trade-offs embodied in process choice. Edinburgh's profile showed a straight-line relationship between the product/ markets and the manufacturing and infrastructure provision. However, when the profile is drawn for Norwich it can be seen that a dog leg occured, due to the difference in markets, compared to the similar process and infrastructure investments made in each of the two plants.



○ ◑ Position of the Edinburgh plant on each of the chosen dimensions and the resulting profile ———

● ◑ Position of the Norwich plant on each of the chosen dimensions and the resulting profile -------

Figure 5.6 The product profiles for the Edinburgh and Norwich plants

5.434 The outcome of product profiling

Whereas the previous example of the usefulness of product profiling concerned a proposed strategy decision, this last application was to help in the review of decisions already taken. The full extent of these was considerable when process investments, redundancy payments, remuneration agreements, installation costs and the time and management energy involved were taken into account.

The inappropriateness of the decisions at the Norwich plant as clearly shown by the product profile and the subsequent poor performance understandably became a Teison rather than Hoffman issue. The continued poor performance at Norwich over the period following the review and the cigarette making capacity available throughout the Group were major reasons for the decision to close the Norwich plant. Although in this application the insights only explained the fundamental reasons for inadequate past performance, it reinforced need for strategy to be forward-looking in nature. Product profiling offered clarity in terms of strategic insights but these are not only obtainable in hindsight. Given the total investments (both process and goodwill) involved, the Group were not prepared to let Hoffman Tobacco try again with fresh resources. However, with appropriate strategic insights this could have been avoided.

5.44 INCREMENTAL MARKETING DECISIONS RESULTING IN A MISMATCH : NOLAN AND WARNER

The examples of Ontario Packaging and Hoffman Tobacco, though of general application were more specific in nature. For many companies, changes in market needs happen over time. These incremental changes are often more typical of the source of mismatch that exists in a business than those described in these earlier examples.

Where the market characteristics have changed over time, product profiling maps the fit between the requirements of the current market and the characteristics of existing processes and, in this way, provides an important way of describing these changes and their impact on the business. The key to identifying these differences lies in the recognition that while the needs of the market may have changed, the characteristics of the manufacturing process and infrastructure investments will not. These, as emphasised in Chapter 3, will remain fixed, unless there is further, appropriate investment.

The research described in the next section was undertaken in the early part of the 1980s and led to my developing the concept of product profiling.

Nolan and Warner* is a wholly-owned subsidiary of a UK-based automotive component supplier, the ATMO Group* which is involved in other product areas based on engineering, electronics, chemicals and construction.

The fall-off in demand for cars together with the world recession experienced in the late 1970s and early 1980s had put much pressure onto the company's markets and sales. Appendix 5.6 shows the main product ranges of the business and also the annual unit sales during the period 1978/83.

5.441 Marketing strategy

The company's marketing strategy during this period had been expressed as trying to minimise the reduction in sales revenue (£s) in real terms in an attempt to hold its market share so as to enable the company to expand based on the UK, European and world-wide growth in demand anticipated in late 1983 through the rest of the 1980s. Appendix 5.7 shows that following the sales revenue (£s) drop between 1978 and 1979, the company just about kept actual sales (£s) steady (with 1983 showing improvement on 1981 and 1982) although still 15% below the 1978 figure. Given the overall economic climate, the company considered that it had performed well in terms of minimising the revenue fall in terms of real sales.

A core aspect of the company's marketing strategy through this period was to increase the product range and also the number of products within each range. The RU400 range was introduced in 1981, and 1983 was patently the best

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*These names have been disguised

year to date. Total unit sales of the AC200 range was also higher than at any time, but as shown in Appendix L.1 these were the exceptions in that unit volumes (especially in high selling ranges) had declined substantially.

Over the five years to 1983 markets were very difficult and price competition was very severe. In order to minimise the drop in total sales revenue the company's policy was expressed as attempting to meet all the demands of its customers, where possible. Although its willingness to chase business was recognised as taking the company into smaller volume products, it was also acknowledged as representing additional sales revenue. Minimising the revenue fall in real sales (£s) resulted in the need for increased efforts throughout the company from design and production engineering as well as marketing and manufacturing.

5.442 Manufacturing

The manufacturing processes were in three distinct production units. The first two units involved machining and other processes primarily laid out on a process or functional basis. In addition to the traditional areas such as grinding and turning, there were also departments with processes to provide all or most of the operations necessary to manufacture similar components for the complete range of products. On the non-machining side, the facilities included heat treatment, de-greasing and other prepartory and finishing processes. Although some of the components were bought-in from outside suppliers, the policy had been, and still was, to manufacture internally wherever possible. In more recent years, the plant and process investment which had taken place had been largely to meet the requirements of new products or for specific process improvement (for example, see Note 2, Appendix L.3). The third production unit concerned sub-assembly, final assembly and test. This involved sub-assembly and assembly lines for the higher volume products and bench layouts to meet low volume requirements.

Information on some representative products in each of the three production units is given in Appendices L.4-L.8 inclusive. At the time of the research, the manufacturing task was seen to be supporting the introduction of new products within an existing range and also the need to reduce manufacturing costs throughout the process. Over the last year there had also been substantial pressure to reduce inventory, in order to improve the cash flow situation. Due to the wider product range and the need to respond quickly to customers' changes in call-offs, this had proved to be difficult. However, reducing inventory was seen to be a high priority in the future and would form part of an essential strategic review of the manufacturing function.

Since the mid to late 70s there has been a stringent check on process investment. This corporate restriction had meant that, apart from that necessary to meet new product requirements, investment has been difficult to come by. In fact, only where process cost savings could be achieved had any investment been forthcoming. Consequently, the company was, by and large, running in 1983 with the processes bought some 6 or more years before.

5.443 Manufacturing strategy review

The essence of the Company's marketing strategy had been to maintain sales revenue levels in order to retain the organisational structure and market presence on which to base its future prosperity in line with the forecast sales growth in the mid and late 1980s. However, the company was facing a major problem at the time of this new era. Manufacturing could not support the new mix of sales and make adequate profits. A review of Appendix L.3 shows that profits had fallen dramatically (even ignoring inflation) from more than £2.9m to less than £0.5m in the five years from 1978 to 1982 with a corresponding decline in return on investment.

The principal reason for this was that manufacturing was attempting to support a significant decline in volumes with little change in its processes or infra- structure provision. As shown in Appendices L.8 and L.9 the decline in unit volumes had been dramatic. The only increases were in fact in low unit volume ranges which would do little to redress this mismatch between the characteristics of its orders and manufacturing's ability to support these levels and make adequate profits. Furthermore, as shown in Appendix L.9, manufacturing had artificially maintained shop floor volumes in an attempt to protect its high volume processes from the decline in customer order size/ call-offs, a fact, which had contributed to the increase in total inventory levels by some 40%.

Furthermore, the disparity between the high volume nature of its manufacturing processes and the low volume markets at the time of the research was compounded by its corporate investment rationale. Apart from capital allocations to purchase new process technologies, the investments in the last few years had been made to reduce manufacturing costs (see Note 2, Appendix L.3). This outcome was supported by an analysis of the process time reductions in the period 1978-1983 for one high volume component as shown in Appendix L.10.

The strategic task facing manufacturing was to provide a means of demonstrating this such that the business could review the cause of the present difficulties which had resulted in a severe reduction in overall profit performance. Such a way was afforded by product profiling.

In the instance of Nolan and Warner the basis for comparison was to illustrate the incremental nature of market change. Whereas the current year of the research was one point, the other was not the previous year (as is the usual comparison made by most companies) but the year in which the company had made its major investments, ie 1978. For, this is the year which would represent the nature of the market needs the support for which the process investments had been made. The resulting profile is given as Figure 5.7 and clearly shows the outcome.

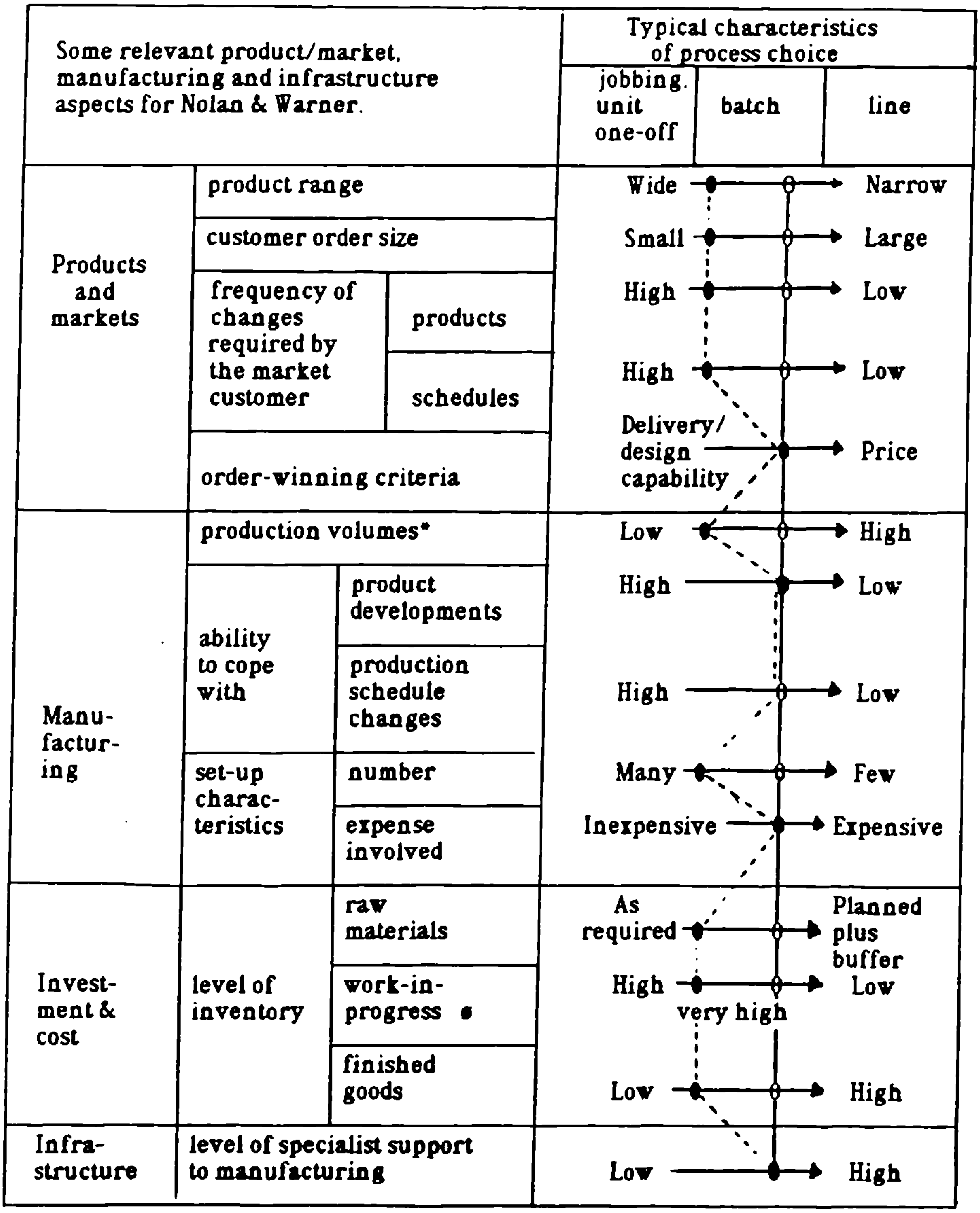
5.444 The outcome of product profiling

The company's failure to redress its manufacturing strategy in line with its changing markets was the root cause of the 1983 profile. Unless, therefore, investment was made to realign manufacturing in terms of its new markets and to test whether changes to its marketing strategy would not be to the overall benefit of the company, then the poor level of corporate performance would continue.

In the event, the ATMO Group allocated investment on the basis of ROI performance. Nolan and Warner was now towards the bottom of the Group's ROI league table and did not, therefore, have the credentials to attract the necessary investment allocation. ATMO had, in fact, (without fully realising it) condemned Noland and Warner to fail. By starving it of investment (based on financial criteria) it had made the strategic decision that this business would not recover. Thus, it is important that investment decisions are based firstly on strategy and secondly on financial criteria and not solely on the latter.

However, ATMO would not be persuaded otherwise. Nolan and Warner, therefore,

- changed its marketing strategy and deliberately stopped going for low volumes



O● 1978 company position of each of the chosen dimensions and the resulting profile ————

●O 1983 company position of each of the chosen dimensions and the resulting profile ----------

Figure 5.7 Product profiling to reflect the level of match/mismatch between manufacturing's ability to support the company's markets of 1978 and 1983 respectively

- negotiated price increases for low volume demand items. One customer however, refused to go along with this proposed increase and notified Nolan and Warner that it would place its business elsewhere. Eighteen months later this customer came back to Nolan and Warner. It had found that aspects of support (technical back-up, delivery speed and willingness to meet schedule changes) were an essential feature of their own needs and ones that Nolan and Warner had supplied in the past but which it had failed to recognise were part of Nolan and Warner's provision - the price, therefore, needed to reflect this

- shed much of its very low volume requirements to a small volume manufacturer within the ATMO group set-up
- sub-contracted a significant amount of additional manufacturing work
- shed its labour and overheads (eventually by two-thirds) with this process positioning change
- survived - it is currently making a more acceptable return on investment

5.5 USING PRODUCT PROFILING : SOME GENERAL OBSERVATIONS

The examples given in the previous section illustrate the role product profiling may play in helping a company to check its existing product and process choice relationship, and allow, where relevant, comparisons to be made between similar applications, or to measure trends over time. However, although two of the applications are based on hindsight, the purpose of strategy is to be forward-looking. When a company is able to illustrate current positions and future alternatives, it then becomes possible to discuss alternatives, and determine which strategic direction best meets the needs of the business. It is this role that gives the concepts of product profiling its strategic orientation, and that companies find useful in helping to determine the business perspectives of manufacturing.

However, where companies are, for whatever reason, experiencing a mismatch between their current market needs and existing manufacturing processes and infrastructure, they face a number of alternative choices. They can:

1 Live with the mismatch.
2 Go some way to redressing the profile mismatch, by altering the marketing strategy.
3 Go some way to redressing the profile mismatch, by investing in and changing manufacturing and its infrastructure.

Alternative 1 affords companies the opportunity to consciously make a decision on the trade-offs involved. It does not in any way imply this to be an incorrect strategic choice. What it does do is to bring a company's expectations more in line with reality, makes it aware of the real costs of being in different markets, changes the measures of performance by distinguishing between those based upon business-related decisions and those based upon functional achievement, and raises the level of corporate consciousness about the overall consequences of maintaining product profile status quo, or the decision to improve or widen any mismatch that may exist. Furthermore, future decisions concerning new products are now more able to incorporate these essential perspectives and thus help arrive at decisions which reconcile the diverse functional perspectives under the mantle of what is best for the business.

Alternatives 2 and 3 concern ways of straightening existing - or consciously avoiding the creation of new - mismatches, which may be taken independently or in unison. *Alternative 2* represents the influencing of corporate policy through changes or modifications to existing or proposed marketing strategies. In this way, the implications for manufacturing of marketing decisions are addressed and included as an integral part of the corporate strategy debate. Thus, manufacturing is able to move from the reactive stance it currently takes to a proactive mode, so essential to sound policy decisions.

Alternative 3 involves a company in the decision to invest in the processes and infrastructure of its business, to either enable manufacturing to become more effective in its provision of the order-winning criteria and support in the market place for existing products, or to establish the required level of support for future products. As in *Alternative 2*, it enables manufacturing to switch from making a reactive to make a proactive response to corporate marketing decisions. Thus, by receiving pertinent inputs at the strategic level, the business now become mores fully aware of the sets of implications involved, and is able to arrive at strategic options, based upon the relevant and comprehensive inputs necessary to make sound judgments at the strategic level.

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APPENDIX K

DETAILS OF THE PRODUCT PROFILING APPLICATION FOR HOFFMAN TOBACCO

Appendix K contains supporting details of the research work completed at Hoffman Tobacco. In this way it gives the essential data on which the research application was based and the necessary background against which the research findings need to be set.

APPENDIX K.1

PERCENT OF THE VOLUME OF PRODUCTION BY BRAND TYPE AT EACH FACTORY OVER THE THREE YEAR TRANSITION PERIOD

Factory location	Brand type	Percent Product by volume each year		
		1	2	3
Edinburgh	Virginia Mild - UK	33	47	61
	- Europe Duty Free[1]	10	21	32
	Hoffmann Special	20	14	7
	Hoffmann Special (Plain)	25	15	-
	Other brands[2]	12	3	-
	Total	100	100	100
Norwich	Virginia Mild - UK	35	17	10
	- Europe Duty Free[1]	18	10	-
	Hoffmann Special 10s	15	18	19
	Hoffmann Special	16	15	17
	Hoffmann Special 50s	3	4	3
	Gold Tip	6	10	14
	Hoffmann Mild[3]	-	3	3
	Hoffmann Special (Plain)	-	9	16
	Mild Leaf	-	3	4
	Other brands[4]	7	11	14
	Total	100	100	100

Notes (1) These were packed in both 200s and 300s
(2) This category at Edinburgh totalled 6 brand types in Year 1
(3) This brand was produced as both a plain and tipped cigarette
(4) This category at Norwich totalled 17 brand types in Year 3
(5) Year 3 above was the current year in which the research was undertaken
(6) Brand names and other figures have been disguised but the relationship between the years has been retained in order to maintain the relative nature of the contrasts involved

APPENDIX K.2

OVERVIEW OF CURRENT BLENDS, BRANDS, PACKING SIZES AND PRODUCT CODES AT EACH FACTORY LOCATION

The current range of products reflects its need to increase the number of cigarette types as part of its competitive response in both home and export markets. In the normal way, a product code was allocated wherever there was a difference in blend, brand, length of cigarette or packing specification from one requirement to another. Thus, export orders often required packing and insert changes, the number of cigarettes per pack would differ to facilitate the use of slot machines (see Note 1) and different packs are used to meet the perceived needs of customers. Below is a summary of the differences currently required at each plant

Number of specifications used in a typical month		Edinburgh	Norwich
Average	blends	3	12
	brands	3	25
	product codes	65	560
Number of different packings per cigarette size (mm)	70	-	4
	80	-	2
	84	1	5
	95	-	2
	100	-	2

Notes 1 Slot machines refer to the coin-operated, dispensing machines increasingly used in clubs, restaurants, airports and other public places where customers serve themselves through inserting the appropriate amount of cash required

2 The different packings used included hinged lid, shell and slide, soft cup, box and drum

3 The cigarette size above (for example 70, 80, 84) referred to the length of a cigarette in mm

APPENDIX K.3

PRINCIPAL SECONDARY EQUIPMENT AT THE EDINBURGH AND NORWICH PLANTS BEFORE AND AFTER THE CAPITAL INVESTMENTS HAD TAKEN PLACE

Equipment category		Edinburgh		Norwich	
		before	after	before	after
Filter rod makers		6	6	6	6
Free-standing plain	makers	2	-	4	6
	packers	2	-	4	6
Free-standing filter	makers	30	8	34	7
	packers	40	10	42	8
Linked makers and packers - filter		-	15	-	20

Notes 1 Filter rod makers are the machines used to make the filter tips - see Attachment 2

2 The equipment for making and packing plain (or non-filter tip) cigarettes which was originally sited in the Edinburgh plant was transferred to Norwich when these products were also re-sited

3 The investments involved to meet these changes (new equipment, reorganisations and compensation payments) totalled over £40m for both plants. About 80 percent of this was spent on new equipment and the re-organisation of existing equipment (including linking the making and packing processes) both within and between the two plants

APPENDIX K.4

RATIONALE SUPPORTING THE CAPITAL INVESTMENTS SUMMARISED IN APPENDIX 5.3 AND THE REDUCTIONS IN LABOUR WHICH RESULTED

The rationale supporting the capital investments in both plants was principally for the following reasons -

The linking of a maker and packer required a conveyor and reservoir facility which provided an automatic feeding system from one process to the next. Previously (and currently with free standing equipment) indirect labour was used to transport cigarettes from the makers to the packers. This would necessitate the movement of cigarettes loaded onto trolleys often from one floor to another and usually involving lengthy distances.

In order to decouple the maker from the packer the total holding of made cigarettes in a conveyor and reservoir system was in excess of 50,000. Thus, this afforded the two processes a practical level of independence within the linked system.

The advantages offered concerned a significant reduction in indirect labour together with small (but significant in terms of actual costs) savings on direct materials, particularly tobacco and is explained in more detail below.

The principal gains which accrued from these changes were

1 **Direct labour cost reduction** - the introduction of higher speed makers and packers, together with the increased efficiency of the new equipment*, resulted in a reduction in direct labour requirements

2 **Direct material cost reduction** - the new equipment and concept of linked processes resulted in a reduction in material loss/waste from lower levels of rejects and damaged product in the process

3 **Indirect labour reduction** - the linked process concept reduced the need for indirect support in several ways, including -

- movement of product
- storage
- administrative support
- maintenance/technical support for the equipment

The expected results of these improvements were a 20% reduction in factory-related staff and an anticipated 1% reduction in material costs. Over 90% of this planned labour reduction was achieved by the introduction of linked processes in the two plants.

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* Efficiency in this context referred to actual output achieved compared to the expressed or standard output and came from reduced downtime and the

APPENDIX K.5

DOWNTIME ANALYSIS EXPERIENCED ON THE LINKED PROCESSES AT THE NORWICH PLANT

Reasons for stoppage		Downtime as a percent of total observations	
Making machine			
Related directly to linked process	Conveyor/reservoir fault	2.1	18.6
	Reservoir full	3.3	
	Need to empty reservoir on a changeover/end of a shift	9.4	
	Other	3.8	
Unrelated to linked process	Maker fault	14.2	16.7
	Other	2.5	
Total for the making machine			35.3
Packing machine			
Related directly to linked process	Conveyor/reservoir fault	2.7	17.7
	Reservoir empty/waiting on a changeover/start of a shift	12.9	
	Other	2.1	
Unrelated to linked process	Packer fault	16.1	18.9
	Other	2.8	
Total for the packing machine			36.6

Note The conveyor/reservoir faults given for both the makers and packers were independent of each other as they were related to the feed into and out of the reservoir

APPENDIX L

DETAILS OF THE PRODUCT PROFILING APPLICATION FOR NOLAN AND WARNER

Appendix L contains supporting details of the research work completed at Nolan and Warner. In this way it gives the essential data on which the research application was based and the necessary background against which the research findings need to be set.

APPENDIX L.1

ANNUAL UNIT SALES BY PRODUCT RANGE IN THE PERIOD 1978 - 1983

Product Range	Unit sales for the year ended 31 Dec					
	1978	1979	1980	1981	1982	1983
VR100	105650	74500	72880	58400	51790	45600
VR150	74600	44850	45950	31250	30880	36040
AC200	3110	3290	3120	3270	2650	4160
AC250	52620	34560	42360	28350	28520	37100
NT300	25750	23170	22200	16630	15440	12610
RU400	-	-	-	170	110	250
Total	261730	180370	186510	138070	129390	135760

NOTES

1 The above are in terms of units sold and all figures have been rounded. As the unit price varies and has changed over time, it is not relevant to relate these unit volumes to the sales turnover (£s) levels given in Attachment 2.

2 Figures for only the first 8 months of 1983 are available, and these have been increased on a pro rata basis.

3 Each product range above comprises a number of general products each at a different stage in its own life cycle.

APPENDIX L.2

Year ended 31 Dec

All figures in £000s

	1978	1979	1980	1981	1982
TOTAL FIXED ASSETS (see Note 2)	6963	7751	12860	12589	11727
CURRENT ASSETS					
Inventory (see Notes 1 and 3)	7219	8378	9407	9817	10206
Debtors and prepayments	2893	2970	3010	2930	3209
Cash	7	7	8	17	11
	10119	11355	12425	12764	13426
LESS CURRENT LIABILITIES					
Creditors and Accruals	4004	4816	3186	3174	2904
Bank Overdraft	2667	5837	5762	8593	8458
	6671	10653	8948	11767	11362
WORKING CAPITAL	3448	702	3477	997	2064
NET ASSETS EMPLOYED	10411	8453	16337	13586	13791
FINANCED BY					
Inter-group capital account	7453	7892	12575	10714	13308
Profit (loss) for the year	2958	561	1062	172	483
Inter-group loan	-	-	2700	2700	-
	10411	8453	16337	13586	13791

APPENDIX L.3

NOTES

1 The inventory values shown here are net of reserves, which averaged in this 5 year period between 20-30% of the gross inventory value.

2 About 75% of the plant investment in 1980 was to provide the manufacturing processes for new finished products. The other quarter was to help improve the process on a critical component. In turn, this improvement would lead to reduced manufacturing costs and a subsequent release of capacity in the related parts of the process.

3 Sales and inventory breakdown for each of the five years from 1978-82 are below:

Year	Sales £m	Inventory (£000s)			
		raw materials	work in progress	finished goods	total
1978	31.7	310	4184	2725	7219
1979	23.4	488	4956	2934	8378
1980	27.0	624	6579	2204	9407
1981	26.1	606	6960	2251	9817
1982	26.9	637	7494	2075	10206

APPENDIX L.4

Product range	% Total Manufacturing Costs			
	materials	labour	overhead	total
VR100	40	13	47	100
VR150	39	13	48	100
AC200	33	16	51	100
AC250	42	14	44	100
NT300	35	16	49	100
RU400	43	15	42	100

Notes

1 Overhead recovery rates were based on direct labour hours

2 The percentages given above were based on three products in each range which were made for original equipment sales but reflected the spread of volumes associated with the product range reviewed

3 Original equipment (OE) sales referred to orders for products which go onto vehicles currently in production at customer's assembly plants. When vehicles were no longer being built the orders for products reverted to sales to meet the demand for spares or service only. Where a vehicle had been made for some years then demand for products would comprise both OE and spares or service sales

APPENDIX L.5

AVERAGE MONTHLY CALL-OFFS FOR TYPICAL COMPONENTS WHICH GO INTO THE ASSEMBLY OF ONE OR MORE PRODUCTS WITHIN THE FOUR PRODUCT RANGES, TOGETHER WITH THE ORDER QUANTITIES ISSUES IN THE FIRST PRODUCTION UNIT IN THE PERIOD 1980/83

Product information			Monthly average call-offs and typical order quantities			
range	component	issue details	1980	1981	1982	1983
VR100	VR108/ 1426	call-off	2600	2520	1970	1490
		order quantity	4750	4250	3250	3500
	VR111/ 3278	call-off	50	-	-	-
		order quantity	255	-	-	-
	VR115/ 1002	call-off	2500	2500	2500	1500
		order quantity	2500	2500	2500	2500
	VR116/ 2614	call-off	800	240	140	200
		order quantity	800	800	440	400
VR 151	VR151/ 1214	call-off	-	400	1200	900
		order quantity	-	600	1200	1200
VR150	VR164/ 1019	call-off	15	16	12	-
		order quantity	25	25	25	-
	VR170/ 2630	call-offs	-	-	600	300
		order quantity	-	-	200	100
	VR171/ 2710	call-offs	-	5	10	3
		order quantity	-	10	10	10
AC200	AC215 1816	call-off	100	70	50	25
		order quantity	100	100	100	75
AC250	AC255/ 4914	call-off	400	300	300	400
		order quantity	400	400	400	400
	AC270/ 5300	call-off	20	10	10	20
		order quantity	20	20	20	20

Notes
1. A call-off was the monthly delivery requirement to the customer
2. The order quantity was the number of components issued to and processed through the First Production Unit - also known as batch size. These were not issued each month but only as required
3. Where order quantities exceeded the call-off requirement this implied that manufacturing produced, for instance, two month's sales at a time.

APPENDIX L.6

AVERAGE ORDER QUANTITIES FOR TYPICAL COMPONENTS WHICH GO INTO THE ASSEMBLY OF ONE OR MORE PRODUCTS WITHIN THE CURRENT PRODUCT RANGES, AND PLACED ON THE SECOND PRODUCTION UNIT DURING THE PERIOD 1978/83

Product information		Average order quantities		
range	component	1978	1980	1983
VR100	VR102/1069	10000	5000	2000
	VR111/2178	750	500	150
VR150	VR151/3009	1250	500	500
	VR164/2721	100	100	100
	VR168/5014	80	50	30
AC200	AC215/2748	25	100	25
AC250	AC255/5134	250	400	400
	AC270/5863	10	10	20
NT300	NT306/7010	250	250	100
	NT314/7477	150	100	50
RU400	RU405/2828	-	-	25

Notes 1 An order quantity was the number of components issued to and processed through the Second Production Unit - also known as the batch size.
2 In all instances, the order quantities were taken as the average of the actual issues during the year.

APPENDIX L.7

SUMMARIES OF TYPICAL COMPONENT ROUTINGS THROUGH THE FIRST PRODUCTION UNIT INCLUDING MACHINE CATEGORY, PRODUCTION TIMES AND CHANGE-OVER TIMES

Number of machines used in each category to complete all the operations for 7 typical components				Cumulative total standard time		
				process time (standard minutes) per component	change over time (standard hours)	
					different	like
A	B	C	D		items	
6	5	4	5	126.6	39.0	27.5
3	7	2	2	29.2	34/5	18.0
6	4	3	4	55.5	30.0	11.0
7	5	3	3	47.4	28.0	10 0
6	4	2	3	64.5	21.5	14.0
2	2	3	2	120.1	21.0	15.0
6	4	3	1	162.1	21.5	12.5

Notes

1 Machine categories were
  A General-purpose machines
  B Machine dedicated to one of the product range (eg VR100)
  C Machine dedicated to part of a product range (eg part of VR100 range)
  D Machine dedicated to one operation on one component by a fixture (eg can only complete one operation on component VR108/1426)

2 The operations do not include in-process testing

3 All machines were laid out by function or process

4 The 7 components shown above were representative of the range of work involved

5 The cumulative total standard time columns mean that, for the first component, the total process time of 126.6 standard minutes per component using 20 different machines from categories A to D inclusive with a cumulative set-up time for these 20 machines of between 27.5 to 39.0 hours

APPENDIX L.8

ANNUAL UNIT SALES BY PRODUCT RANGE 1978-83

Product range		Annual Call-offs in 1978	1979	1980	1981	1982	1983
VR	actual	105650	74500	72880	58400	51790	45600
100	index	100	71	69	55	49	43
VR	actual	74600	44850	45950	31250	30880	36040
150	index	100	60	62	42	41	48
AC	actual	3110	3290	3120	3270	2650	4160
200	index	100	106	100	105	86	134
AC	actual	52620	34560	42360	28350	28250	37100
250	index	100	66	81	54	54	71
NT	actual	25750	23170	22200	16630	15440	12610
300	index	100	90	86	65	60	49
RU	actual	-	-	-	170	110	250
400	index	-	-	-	100	65	147

Notes

1 All figures have been indexed on 1978 except the RU 400 range, which has been indexed on 1981

2 Source - Appendix 5.6

APPENDIX L.9

REVIEW OF CALL-OFFS AND ORDER QUANTITIES IN THE FIRST PRODUCTION UNIT IN 1980-83

	COMPONENT	1980	1981	1982	1983
VR 108/1426	call-off	2600	2520	1970	1490
	index	100	97	76	57
	order quantity	4750	4250	3250	3500
	index	100	89	68	74
VR 111/3278	call-off	50	-	-	-
	index	100			
	order quantity	255	-	-	-
	index	100			
VR 115/1002	call-off	2500	2500	2000	1500
	index	100	100	80	60
	order quantity	2500	2500	2500	2500
	index	100	100	100	100
VR 116/2614	call-off	800	240	140	200
	index	100	30	18	25
	order quantity	800	800	440	400
	index	100	100	55	50
VR 151/1214	call-off	-	400	1200	900
	index		100	300	250
	order quantity	-	600	1200	1200
	index	-	100	200	200
VR 164/1019	call-off	15	16	12	-
	index	100	107	80	
	order quantity	25	25	25	-
	index	100	100	100	-
VR 170/2630	call-off	-	-	600	300
	index	-	-	100	50
	order quantity	-	-	200	100
	index	-	-	100	50
VR 171/2710	call-off	-	5	10	3
	index	-	100	200	60
	order quantity	-	10	10	10
	index	-	100	100	100
AC 215/1816	call-off	100	70	50	25
	index	100	70	50	25
	order quantity	100	100	100	75
	index	100	100	100	75
AC 255/4914	call-off	400	300	300	400
	index	100	75	75	100
	order quantity	400	400	400	400
	index	100	100	100	100
AC 270/5300	call-off	20	10	10	20
	index	100	50	50	100
	order quantity	20	20	20	20
	index	100	100	100	100

APPENDIX L.10

PROCESS TIME REDUCTIONS IN THE PERIOD 1978-83 FOR ONE HIGH VOLUME COMPONENT ON ITS ROUTE THROUGH THE SECOND PRODUCTION UNIT AND PLANT UTILIZATION CHANGES IN THE SAME PERIOD AND SAME UNIT

Aspect			1978	1980	1983
Total standard minutes per component			83	63	47
Plant utilization %	average		64	44	34
	range	low	14	4	3
		high	89	85	82

Note

Although the plant utilization figures given above relate to the Second Production Unit, they were also typical of the plant utilization changes in the other two Production Units

6 CONCLUSION

By the late 1970s/early 1980s, prominent contributors had effectively established a recognition of the need for research in the field of manufacturing strategy and pointed the way in terms of identifying important areas in which further work needed to be undertaken. At the outset of the research period, therefore, the stage was set. The research questions identified at the end of Chapter 1 proposed that a manufacturing strategy methodology would need to recognise that

a) the 'market-related' inputs to manufacturing strategy formulation are more relevant to this process when expressed in manufacturing, rather than conventional marketing terms

b) invesments in manufacturing will embody different sets of trade-offs between major process and infrastructure characteristics (for example, process flexibility, inventory levels, manufacturing planning and control systems and capacity increases)

c) strategy formulation is more effective when the process recognises that whereas markets are inherently dynamic, manufacturing investments are inherently fixed. Thus, relevant process and infrastructure investments today may not adequately support the markets of tomorrow

The direction of the research described here has been to test whether the above questions are meaningful in themselves and pertinent to businesses in terms of providing relevant manufacturing perspectives. The purpose of this concluding section is, therefore, to review the reported research in line with these questions.

At the outset it would be of benefit to consider the content and purpose of manufacturing strategy. Its role is to provide a functional input into the corporate strategy debate. However, manufacturing typically provides products which are sold into various market segements which themselves comprise both a technical (eg dimensional) and business (eg qualifier and order-winner) perspective. The underlying rationale for doing this is to make acceptable profits and meet other corporate objectives over time.

a) Marketing and manufacturing perspectives of markets

Based on this premise it is necessary, therefore, to review markets from a manufacturing as well as marketing viewpoint. Why is this so?

- marketing's view of the market provides essential insights into sector characteristics, consumer behaviour, appropriate advertising campaigns, product technical dimensions and customer procedures and expectations (eg those relating to government departments)

- manufacturing's view of the market has nothing to do with these perspectives. Yet typically most companies do not re-express their markets, thereby accepting these perspectives of their market as the only relevant view. But, without understanding the manufacturing view of its markets, a company is unable to develop an appropriate manufacturing strategy. The key step in formulating a manufacturing strategy then is looking at markets from a new perspective. In essence, it involves asking questions about the market requiring manufacturing answers. Once this has been accomplished then the rationale under-pinning manufacturing process and infrastructure investments is established. It is then the establishment of appropriate direction which is the essence of manufacturing strategy

- the methodology developed both highlighted and met this essential feature in manufacturing strategy development. The perspectives of order-winners and qualifers provide important new insights in that these refined perspectives express/explain essential and critical differences from a manufacturing point of view

The two company illustrations, HQ Injection Moulding (HQIM) and Precision Steel, illustrate these essential factors. HQIM's failure to identify the relevant qualifers and order-winners relating to its new markets was directly responsible for its inappropriate machine (and consequently mould) investment programme. This aspect is again illustrated by Precision Steel. The initial (and proposed continuation of) volume fragmentation of the Gambert Fabrique sector of its Stockist Steel market is a further illustration of the failure to identify market differences. Similarly, reviewing its Customised Sections segment as a single market obscured essential manufacturing differences. From marketing's viewpint the segmentation was relevant in that differences were identified between these customers and those in its other two segments of Electric Motors and Stockist Steel. However, from manufacturing's perspective, Customised Sections was, in fact, four segments. Only with this insight was the company able to respond to the different requirements of each segment and improve its chances of continuing to grow this important and profitable part of its overall business.

b) and c) Trade-offs and the dynamic nature of markets and fixed nature of manufacturing

Manufacturing investments are large and fixed. Whilst these characteristics in process investments are easily recognised the same is also so for many infrastructure investments. For example, manufacturing planning and control systems can typically cost £2.5 millions and take 2 to 3 years to introduce. Also, once investments have been made firms will be reluctant, (both in terms of expectation and willingness) to repeat these large investments. Given this phenomenon it is essential that companies appreciate the trade-offs embodied in these significant investments. Several important examples of these were given in the illustrations in Figures 5.4, 5.6 and 5.7. In terms of manufacturing this concerns, for example, the level of flexibility, associated volumes, key feature of utilization and the nature of capacity changes. However, it is important for companies to recognise not only the significance of the trade-offs themselves but have a clear appreciation of the fact that these will not change without further and appropriate investment.

For example, high volume processes are not able to effectively support low volume markets. In such circumstances a company could be forced to invest in inventory (and associated costs) or incur higher process (including set-up) costs and subsequent loss of capacity if it was unable or unwilling to invest in new or modify existing processes appropriate to the characteristics of its current markets. The same problems arise for comanies which have invested in manufacturing planning and control systems which it finds too unresponsive and inventory heavy or has existing payment systems which are based on (say) volume achievement in times when market volumes are declining.

Couple this with the inherent dynamic nature of markets (declining volumes, shorter product life cycles and widening product ranges) then the inherent lack of fit between these two critical parts of a firm becomes apparent. Product profiling's contribution is to provide a way of presenting these issues such that it illustrates the nature and extent of change whilst affording the opportunity to discuss causes and ways to improve fit and hence overall business performance. The examples given earlier in Chapter 5 show the actual or potential erosion of fit between a company's marketing and manufacturing strategies. In this way, it highlights the dynamic nature of markets and the fixed nature of manufacturing in terms of the trade-offs which are embodied in its investments.

The findings which are at the core of the work presented here are some of the outcomes of the research I undertook in this period. These are now well documented in papers and books which, in turn, form the basis for manufacturing strategy teaching programmes in the UK, Europe and North America. In addition, they have stimulated both company applications and further academic research in different parts of the world.