Manufacturing Strategy, Product Customisation and the Marketing/Manufacturing Interface

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Chapter 6

Philips BCS

6.1 Introduction

Philips Communications Systems is a division of Philips NV, the Dutch-based international company with interests in many electrical, electronic and entertainments industries. Philips globally has annual sales of £18 billion, with 350 factories in 64 countries. This case was carried out at the Small Switching facility at Airdrie, Scotland. This was formerly part of the Pye group, based in Cambridge, until it became a wholly-owned subsidiary of Philips NV in 1980 and formed one of the businesses in the Communication Systems Group. The Group has six business units as shown in Figure 6.1.

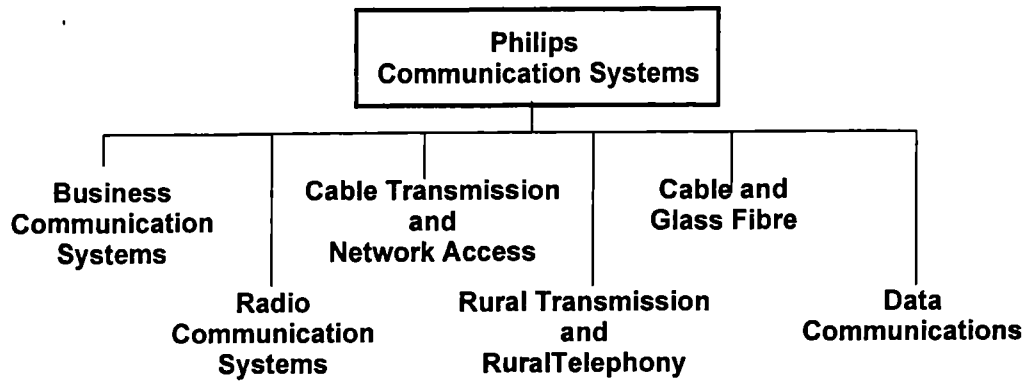


Figure 6.1 Philips Communication Systems Divisional Structure

BCS has two plants, one in Airdrie and one in Hilversum, the Netherlands. As a group, Communications Systems claims to be the third biggest supplier of communication systems in Europe and to offer 'future-proof products for a market

without frontiers'. In connection with this it claims that 'the single European Market will be the major telecoms event of the 1990's'.

Philips as a whole had been through a period of poor financial performance and a company-wide organisational development exercise was underway at the time of the research. Known as "Centurion", this was devised in conjunction with C.K. Prahalad, the Professor of Corporate Strategy at the University of Michigan School of Business Management.

6.1.1 Company Background

Although part of a very large group, the BCS Small Switching (from now on referred to as BCS) facility is very much self contained, and much of the case description can treat it as such. The plant as researched in 1993 was given over to the production of a variety of small digital telephone switchboards and the associated range of terminals (the 'phones' that sit on the user's desk).

Only four years previously, BCS had been referred to on internal documents as Philips TMC - Telephone Manufacturing Company - and its role had indeed been the production in volumes of 5000 per day of basic domestic telephones for British Telecom. But the telecommunications industry throughout the world was being rapidly deregulated and even more rapidly changed by the developments in digital technology. The production of basic telephones was increasingly unprofitable and within the space

of two years the TMC operations contracted from having two production facilities in Scotland (one split into two parts) and a development facility in England to the present state of affairs where development, marketing and all production are housed on one site.

Site	Time ⇒			
Airdrie North	Phone Production	Phone and Old Switch Production	New and Old Switch Production	Very new, new and old switch production
Airdrie South				Development and marketing
Bellshill	Old switch production	CLOSED	Rented accommodation for Scottish development group ("Scottish design began")	CLOSED
Wiltshire	Development	CLOSED		

Figure 6.2 Facilities History - BCS and its Forerunners

The Airdrie organisation chart is a fairly conventional functional structure and is summarised in Figure 6.3. This organisation must be considered bearing in mind that, only a few years previously, there were two production sites and a separate and distant development site. This had necessitated the establishment of a 'Realisation Department' to 'act as a halfway house between development and the factory' according to its first manager. So, although apparently simple, the organisation had been achieved with considerable recent upheaval.

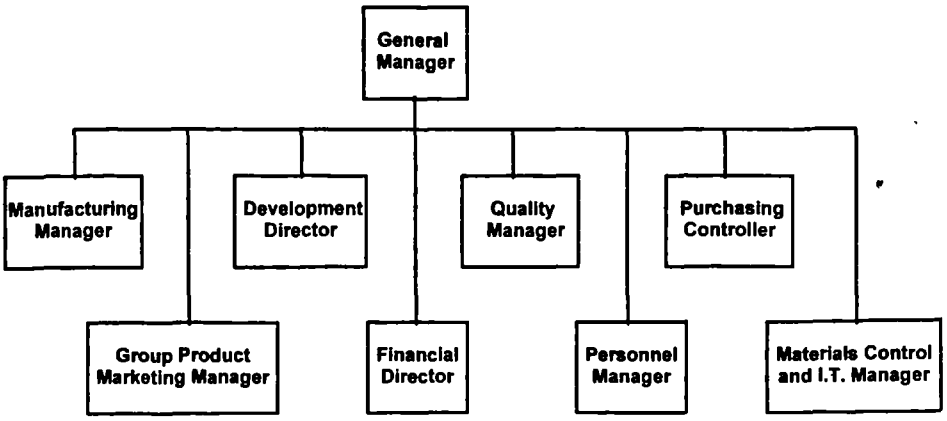


Figure 6.3 Airdrie Organisation

The main products now produced, and which will be the focus of the case, are small switchboard systems including associated terminals. The other BCS plant in Holland produces a continuation range of products under the same brand but for larger numbers of telephone lines; the terminals for these systems are produced at Airdrie.

6.1.2 An Outline of Products and Markets

The key benefit of a switching system is that it reduces the need to buy or rent external telephone lines from the telephone operating company. Many extensions can be connected, directly or indirectly, to the external network, for the cost of only one or a very small number of external lines.

The switching systems produced by BCS provide up to 32 extensions with a variety of features. End-users are typically small businesses, small hotels, dentists, doctors and professional practices. These products are sold either through British Telecom or through dealers who also handle similar systems produced by competitors, most of whom are similar international electronics and consumer goods manufacturers. Also manufactured at the plant are some elements of larger switching systems, a large proportion of which are produced for the German equivalent to British Telecom.

Selling products to customers other than British Telecom was something relatively new for the firm. As TMC, it had been essentially a sub-contractor to BT, producing switching systems and high-volume basic telephones.

6.1.3 Context of the Research

The project began in spring 1993. The main contact was the Manufacturing Manager and, following initial discussions with him and his immediate staff, access was then good to other areas of the firm. Meetings were held with many managers from Marketing, Development, Procurement and Manufacturing functions. Compared to other cases described here, these meetings tended to be more formal and limited in duration - there were very few 'drop-in' conversations. Apart from these meetings, reasonable access was possible to documentary data and to the shop floor.

The emphasis of the concerns expressed by the Manufacturing Manager at BCS was

very much on product-range rather than customisation. The contraction of manufacturing facilities meant that all products were now made in one plant - indeed in one workshop - and, being many and at various stages in their respective product life-cycles, presented significant management problems. The problem facing him was to develop a manufacturing strategy incorporating the plant's four main product families as, in his own words, he 'hasn't got it right'.

Although the project, especially in the earlier stages, addressed the whole product-range, an emphasis was subsequently given to the newest products. These were the source of much of the variety in the plant and two issues associated with these were identified, by the Manufacturing Manager, for more specific attention. First, the slippage in the planned programme to quickly develop a second generation of the new switch was examined. Secondly, by way of a 'typical' example, the development project relating to a variant for a particular international territory was studied in some detail. Customisation was not such a concern because BCS does not explicitly offer customised products. However, it will become clear from the following account that, in all but name, customisation did take place and did cause a good deal of trouble.

Although the concern here is centred on manufacturing, BCS was a technologically-based firm and, especially at the time of the research, undergoing a very active period of product development. As such, the following account includes quite a full description of the product development process.

6.2 Industry Context

By virtue of the type of markets and products involved in this case, it is more than usually important to understand something of the industry context before going on to examine the BCS response to, and shaping of, (particularly in manufacturing), that context. This section will briefly outline the technological and market changes that are important here, then discuss the implications of these for BCS, particularly in terms of their products.

6.2.1 Technology Context

Telecommunications technology has undergone considerable change in recent years. The most fundamental of these is the change from analogue to digital signals in the external network (the 'system X' exchanges in the UK for example). This has converged internationally on the ISDN (Integrated Services Digital Network) standard. This has two notable consequences. Externally, it means that networks are moving from locally-specific to internationally-standardised operating conditions and parameters. Internally, it means that voice communications are in principle no different to other forms of digital signal and that there are virtually unlimited possibilities for linking together telephones, personal computers, facsimile machines and, as other media converge on digital signals, cameras and photocopiers (Figure 6.4). In their promotional literature, Philips emphasise their involvement in the definition of the standard and the advantages that that will give them.

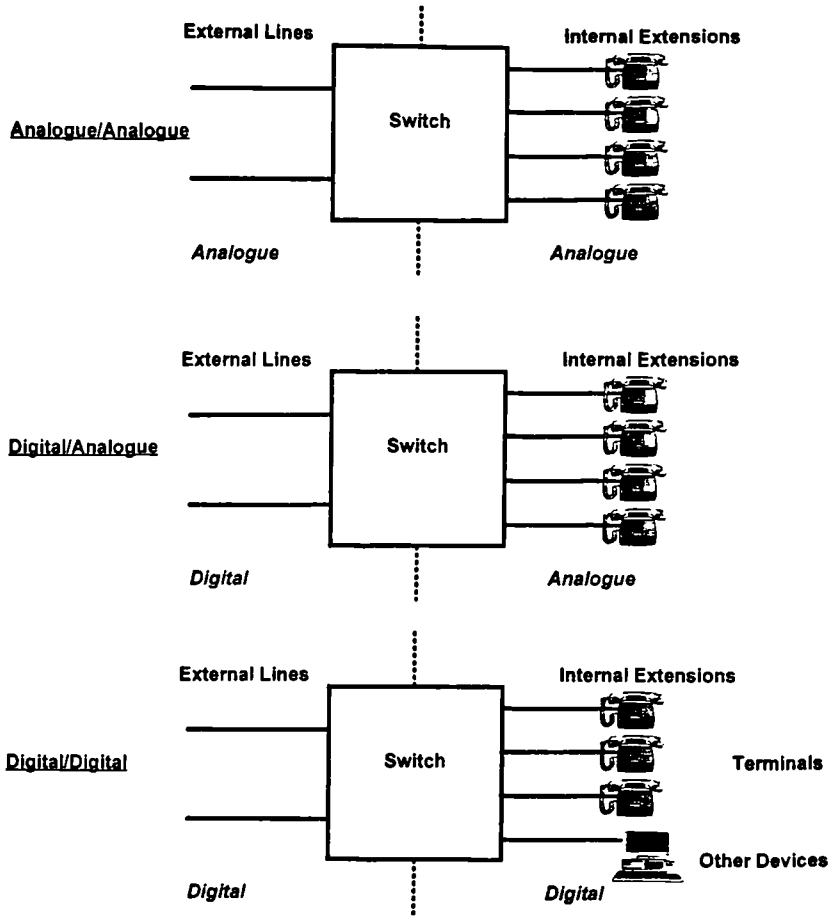


Figure 6.4 The Move to Digital Telecommunications

A second very important development is in the area of cordless and mobile telephones. In the business sector there is now the notion of the 'cordless office', although this has less immediate and profound effects on the BCS business.

6.2.2 Market Context

Alongside and no doubt connected with the technological changes are the recent shifts in the structure of telecommunications operators. In many countries former monopolies, often state-owned, have given way to greater competition between private companies for the provision of telecommunications services and products. In the UK,

for example, British Telecom (BT) was privatised and the market opened to competitors. Whereas BT were the only option for everything from operating the telecommunications infrastructure through to selling a phone, now there is greater or lesser competition in most aspects of the business. This has been extremely intense in the manufacture and supply of systems and telephone equipment, particularly as the technological standardisation meant that the technology was no longer industry- or country-specific.

6.2.3 Small Switch Markets

The general trends toward deregulation of industries and technological shift toward ISDN have not affected all aspects of the telecommunications business in the same ways or at the same rate. This section will consider the small switch market, how it has been affected by these changes, and how this has in turn affected BCS.

6.2.3.1 Channel Overview

The Group Product Marketing Manager summarised the distribution channels as follows. First, the Airdrie Factory sells to the National Sales Organisation (NSO), of which there are about 15. Then there are three channels: PTTs (Post, Telegraph and Telecommunications); Direct Sales, such as large customers buying multiples of small systems e.g. major banks; and Indirect Sales, i.e. through dealers and distributors.

The first of these was described as representing 'quite a lot of business'; the third is the one the most effort goes into and the one that BCS are seeking to grow.

6.2.3.2 Market Characteristics

This account of the characteristics is based on interviews with one of the Product Marketing Managers, complemented by discussions with other managers.

Before deregulation, British Telecom was the monopoly supplier of switching systems, large and small. Deregulation meant that new competitors - equipment manufacturers, dealers - entered the market. However, some parts of this business were more attractive to potential entrants than others. Summing this up, the Product Marketing Manager commented that 'the market share [BT] have retained is inversely proportional to the size of the switch'; that is, the small switch market has not proved so attractive to new entrants as that for large switches. This had not been predicted by the industry, where expectations were that BT's share would be heavily undermined in all markets.

The principal reason for the relatively low attractiveness of the small switch market is that the cost to the dealer, in terms of time spent selling the switch and installing it, is not much less for a small switch than for a large switch. Consequently, the large switch market was the first to come under severe competitive pressure.

The customers for small switches are small businesses and professional practices. Whereas large organisations may have specialists who are responsible for telecommunications and who will therefore have the time and expertise to carefully select the best possible solution, small organisations don't, and buy from suppliers they know. As the Product Manager put it:

> *'the small businessman, he probably still thinks he is renting his system from the Post Office, he has never heard of BT - they still talk about the Post Office. He doesn't have any specialists in telecomms in his organisation, there are probably only five or six people in his company and they are all too busy selling, making, counting the figures and so, when he wants a [switch] product, he will ring...his local BT office and he may end up ringing nobody else because he is in too much of a hurry to get on with doing his job.'*

As a result of this, BT have retained 60-70% of the market, despite liberalisation. Not foreseeing this, many dealers and manufacturers joined the market on liberalisation:

> *'a lot of dealers came in, a lot of companies manufactured products that were very small, single line, two-line products because they thought they could make money, it was an easy-to-understand market, it was nice and simple, it is a box with a line coming in and extensions going out and you hang telephones on the end of it...So, a lot of companies came in, ourselves included, and made products that would reach this market and it all went drastically wrong for everybody, including us...'*

This leaves the large number of new entrants to contest the 30% share whilst BT

carry on exploiting the market's 'inertia'. The conclusion was that the 'only way to address that market was to go in with BT'. Philips were successful in this and sold, exclusively to BT, two products: The Renown, launched in 1989 and the 2+8, launched in 1991. Both were still in production at Airdrie at the time of the research.

Another facet of the conflicts between these markets was described by the Group Product Marketing Manager. Referring in particular to the newest product, the Sopho-S, he commented that it had been designed initially with the PTTs in mind as the main market. As such, price had not been the paramount concern, but the BCS reputation as a 'high-tech, leading-edge' supplier had been. PTTs generally accept novelty in design but dealers, to whom BCS in fact found themselves trying to sell the majority of the product, don't welcome novelty or need many of the benefits the technological advances provided. Pricing into this market had to be along similar lines to the analogue forerunners of the new switch and this in turn necessitated cost reductions. The PTTs had also envisaged selling the ISDN benefits, whereas dealers were more interested in using the system's capabilities to provide as many extensions - of any sort - as cheaply as possible. (This is the so-called 'co-location' facility, where one internal line can be used to provide two extensions, albeit with reduced facilities for each extension.) The positioning of the product was changed 'at the last minute' to market it as a co-located bigger system, underplaying the alternative positioning of the new product as a smaller system but with advanced facilities.

Product Marketing saw a need to 'move the dealers up in value-added via the NSOs' - i.e. sell higher-priced products. One factor making this a possibility is that, to the

end-user, payment often takes the form of some kind of leasing arrangement, so 'price' is de-sensitised. And one way in which value-added can be increased - at least in the perception of the customer - is to move toward products for smaller niches in the market - the so-called 'line-of-business' approach. This was 'vaguely' included in the early conception of the new Sopho-S product, but has become a stronger theme as the product has become established. Recognising that it may be difficult to provide, within a manageable number of product variants, the features required by all types of small switch user in all countries, the line-of-business concept involves specialising in narrow segments by type of user. For example, a switch might be developed for doctors' practices which, without major additional features, could be packaged as a switch designed especially for the purpose and sold at a price premium. This was to be pursued, but had not been put into effect at the time of the research.

The Manufacturing Manager gave his perception of the important issues in two of the channels - the PTTs and the indirect channel. With BT, the important factors are Philips' organisational values and development activities. BT want quality, delivery and products that aren't too expensive. Similar issues are important to other PTTs, notably the German DBP. In the case of indirect channels, the end-customer typically has only a vague idea of his/her requirements, which are usually fairly basic, and has £2500 to spend. The dealer 'knows how much money there is to be made and wants some of it'; the dealer is 'into features' and will 'come back to Philips and complain that the business was lost 'because we don't have a button to do XYZ''. Dealers are not concerned about delivery.

The Commercial / Forecasting Manager added other comments about the dealers. In his view they are 'cashflow-oriented' and very interested in a speedy delivery response, especially in the UK. Many dealers sell competitive products from other manufacturers and have 'no supplier loyalty'. Broadly agreeing, the Logistics Manager felt that, to the indirect channel, availability and leadtimes were most important.

6.2.4 Implications for BCS

Philips TMC sold analogue systems and telephones to the British national monopolist. It is not surprising then that the changes described in sections 6.2.1-6.2.3 were very significant for it. As low-cost competitors entered the basic telephone market BCS 'effectively came out of the telephone business' (in the words of one manager).

The four main products produced at Airdrie reflect these changes:

'British Telecom': Oldest products, in low volumes. Analogue switching systems produced solely for BT, who own the designs. Volumes low, some have agreed termination dates.

Sopho-K: Analogue small switching systems developed by old Wiltshire development department and still produced in some volume. Developed as a UK product, then converted for some international territories

Sopho-S: New digital small switching system. Developed entirely in Scotland initially conceived as European product and aimed at full ISDN compatibility (larger versions in same range made in the Netherlands).

Digital Terminals: Terminals only for large switching systems, central units of which are made in Philips' plant in the Netherlands.

In these is evident the move from British-Telecom exclusive products, first to more generic UK products, then to European, and then to international products. At the same time, there has been a shift from analogue to digital operation. Thus not only have the basic product technologies changed fundamentally, but the plant's position has shifted from exclusive sub-contractor to BT to supplier to independent agents all over Europe. This meant, amongst other things, developing an identity and brands as a supplier in its own right, rather than quietly manufacturing 'things' onto which would be placed someone else's (usually BT's) badge. Rapid introduction of new products had been necessary to generate revenue for the plant to replace that lost by withdrawal from the 'basic telephone' business.

Managing all these products in one production shop was the difficult task. Having outlined some of the factors contributing to making that task necessary, the next section will describe some of the formally- documented strategies that BCS had set out to respond to the business environment.

6.3 Strategy Statements

A number of very detailed strategy documents were made available. In this section, important aspects of the following documents are summarised:

- A Marketing Plan, written in 1989
- A Manufacturing Strategy, written in 1989

6.3.1 Marketing Strategy

This is based on a 1988/89 marketing document. Under the heading Product Mix and Positioning, the overall intent is:

> *The Product Group BCS aims to supply the Philips National Sales Organisations with a comprehensive small switch portfolio.*
>
> *The target market is the small business user...Primary considerations in this market are:*
>
> - *Price*
> - *Reliability*
> - *Ease of use*
> - *Ease of installation*
> - *Ease of maintenance*
>
> *The number of features regarded as minimum is growing as*

manufacturers, particularly those from the Far East, compete for market share on this basis.

Further on:

Philips products are not so heavily featured as some competitive offerings, but show many of the characteristics necessary for the target market. Specifically, they are particularly cost-effective, reliable and easy to install and maintain. ....the existing Sopho-K portfolio has an attractive cost level to allow the products to be priced aggressively to assist in the task of building market share. The current analogue Sopho-K range provides cost-effective solutions to today's market requirements.

It follows that the criteria of 'cost-effective communications solutions for small businesses' should provide the basis for our positioning.

The plan goes on to note that the need for digital systems will come to be perceived increasingly, although many of the user benefits are not available at the time; digital products will become available but will be considerably more expensive than analogue.

Whilst the price-sensitive nature of the target market currently inhibits the use of digital technology, in the longer term (1990 onwards), digital systems will become mandatory. The Sopho-S range targeted for launch in 1991 is designed to meet this need.

And further on again (in bold font):

Philips will be one of the few players who will have a truly pan-European product portfolio. The adoption of an international product portfolio is essential to profitability given escalating development costs, competitive pressures and shortening product life cycles.

The plan goes on to describe the features of the new product and sets out the planned launch and internationalisation timetable as shown in Table 6.1 (L, M and S refer to large, medium and small systems respectively).

Table 6.1 Proposed Internationalisation Timetable - Sopho-S

Territory	1991				1992			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
UK	L	M,S						
France							S	M,L
Germany					S	M,L		
Italy			L	M,S				
Spain			S	M,L				
Netherlands					L	M,S		
Nordic			L	M,S				
Portugal					L	M,S		
Belgium					L	M,S		
Australia					L	M,S		

The Next main section is the Product Plan. The key themes of this are:

- to provide a comprehensive range of cost-effective switching systems for the small business market

- to identify a clear migration path to the integration of voice, data, text and image at terminal and trunk level, consistent with ISDN

- to exploit existing and emerging standards and regulations to minimise territorial adaptive engineering requirements

- to design for manufacture in terms of technology selection, mechanical design and diagnostics and maintenance and to ensure that Philips products meet the highest quality standards

- to ensure that Philips products remain competitive in respect of features and facilities and to establish a recognisable Philips' design style

The plan emphasises the short term need to enhance the Sopho-K range. The Medium-term product strategy is 'to position Philips as a supplier of a wide range of digital switches and terminals.' The Sopho-S range is 'conceived as an international product'; initial emphasis is to be given to the 6/14 14/36 sizes of system, with the medium-term (90-92) period seeing development of the replacement for the K2/8 and smaller analogue systems. Much of the longer-term plans relate to cordless applications. There is no mention of Sopho-S-2, a second generation of the new switch mentioned elsewhere (see sections 6.3.2 and 6.6.3).

6.3.2 Manufacturing and Procurement Strategy

BCS produced a written Manufacturing Strategy in November 1989. It was written by the current Manufacturing Manager, quite soon after taking up his position, in conjunction with the Purchasing Manager (a section is devoted to the Purchasing Strategy). At the time, the Development department were still on another site and the production facility was split in two. By his own admission, the Manufacturing Manager was:

> *'responsible for pulling it all together, but once it was presented to management I sort of disowned it. Other things were going on - I smelt the opportunity for reducing the cost base and the size of the business'.*

The Manufacturing Strategy is an extensive document and, whilst there is much of importance in it, only a summary will be discussed here. The strategy was written at about the same time as the Marketing plan, from which extracts are discussed elsewhere. Indeed, there are indications that the Manufacturing Strategy was written in response to the 'market plan'.

The structure of the Manufacturing Strategy document is somewhat idiosyncratic. It is difficult to fully understand any sense of hierarchy in its structure, but nonetheless the contents of the sections are of great interest. The main sections and sub-sections are as shown in Figure 6.5. A summary is given in the following paragraphs, adopting a structure close to this.

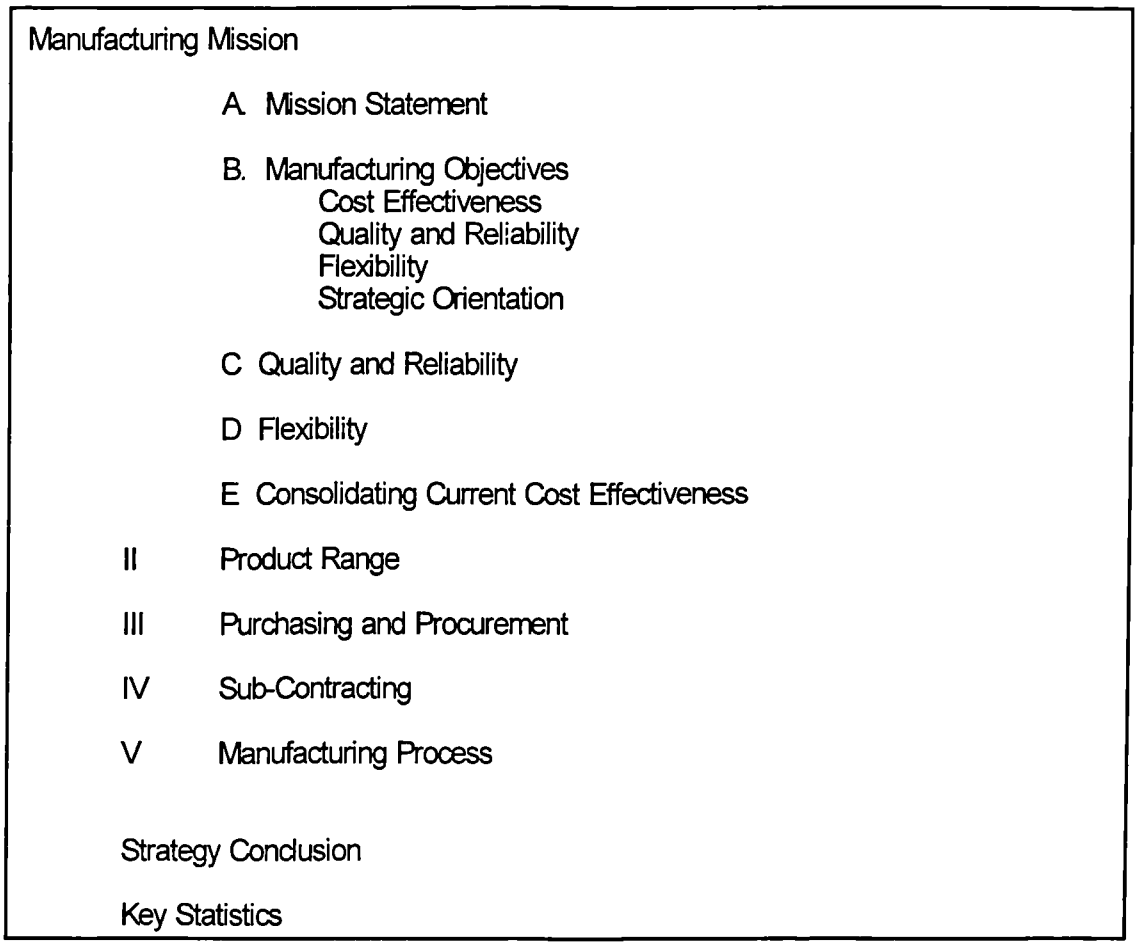


Figure 6.5 Philips BCS Manufacturing Strategy

The Manufacturing Mission, in full, is:

> *'To be a world leader in the provision of communications appliances and services for the office and small business environment. We aim to provide customers with easy to install, easy to use, reliable, adaptable communications systems which give people an independence of time place and format of working, and are recognised as giving 'good value for money'.*
>
> *To ensure that our activities benefit all contributors to the business including investors, employees customers and suppliers. Creating in the*

process a climate of partnership between customers, employees and suppliers.

The manufacturing mission of the PTMC operation at Airdrie is to support this objective by manufacturing, testing, and delivering, Terminals and Key Systems to NSOs at the required quality and price level, and with a delivery and product reliability which places it as one of the leading manufacturers in the world.'

The Manufacturing Objectives, under the headings Cost Effectiveness, Quality and Reliability and Flexibility, apparently all apply to all products and include: cost improvements of inflation plus 5% and the introduction of additional features to systems at no extra cost; Zero defects; 90% of orders within 4-week lead-time promise; 95% on-time delivery of accepted orders; New variant introduction leadtime 10 days in manufacturing and 2 months from release of model.

The Strategic Orientation is in the vein of a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis and takes its lead from the Market Plan. The key points derived from that are: intention to expand into the European small switching market; improvement of analogue and introduction of digital products; phasing out of simple telephone manufacture; establishment of a presence in the rest of the world.

The consequences for manufacturing and supply include: increasing volume; increasing variety, particularly due to international variants; shorter product life cycle; more customers;higher perceived product performance and quality; price pressure 'with high cost reduction targets needed on some specific products'; shorter delivery

times with high delivery reliability.

Specific issues under Quality and Reliability include TQM, SPC, Design for Manufacture and formalisation of shipping. Flexibility is seen essentially as aimed at coping with increased product variety. The measures here include a major initiative to improve MRP II operating practices with aim of 'procuring to forecast and manufacturing to order'. Flexibility in Operations is primarily to be achieved by moving to product-based flowlines, and by cross-training operators, as well as by a number of materials management initiatives.

The section on Cost Effectiveness is the largest in this part of the document. The sub-headings here are Materials, Inventory, Asset Reduction, Utilisation of Skills & Assets and Information Technology Improvements.

The next section discusses the Product Range and, as such, is of particular interest here. This was written at a time when analogue products were the current range and digital products were to be launched within a few months. This was based on product and technology strategies that had been produced by the development and marketing departments in the previous year, and which identified the themes already outlined here in Section 2. In Product terms, this meant that Analogue switches would peak in 1990, following the rapid introduction of a number of international variants. The succession of products is shown in a semi-quantitative graphical form, a version of which is shown here in Figure 6.6.

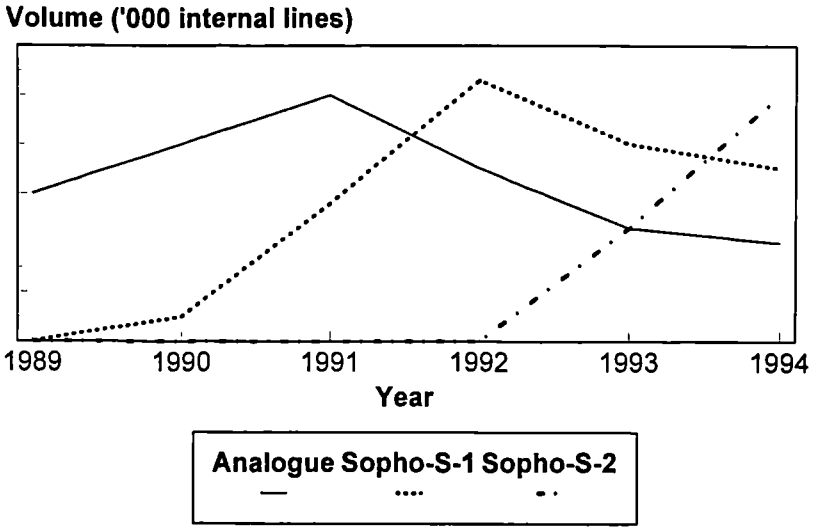


Figure 6.6 Sopho-S-1 and Sopho-S-2 Introduction - Semi-quantitative

The first generation of digital switches (Sopho-S 1) were due for launch in 1990 and seen as having a life-cycle of only 2-3 years, with intent from the outset to produce European variants, particularly for France and Germany. In process terms, this generation would employ similar technology to the existing range. The second generation of digital products (Sopho-S 2) was due for launch in 1992 and was seen as a Full ISDN system employing much more silicon-based circuitry - so-called 'systems on silicon' - compared to the first generation. One componentry issue that warrants specific mention is that this progression involves a move from no Applications-Specific Integrated Circuits[1] (ASICs), to a few, then to many. There is

[1]ASICs are 'chips' that have very specific functions designed-in specially for the product in which they are used

also a move from a very small to a very large proportion of surface-mount[2] components. The transition between and within these product ranges is an important aspect of the case study.

The Purchasing and Procurement strategy, incorporated within the Manufacturing Strategy, cites the internationalisation of products as the key influence. Following from it are the following themes: maximum flexibility at short notice; absolute guarantee of delivery of supplies and 'better than market' pricing; currency protection; enabling early entry of new products. The Strategy is then:

- use lowest vendor base consistent with obtaining the required technologies and chosen on basis of a number of abilities/performance measures

- buying at highest possible level in BOM

- direct Materials Management access for scheduling without Purchasing involvement.

The Sub-contracting section gives a number of criteria that are to be used to assess make-or-buy decisions. Whilst the use of subcontracting to improve flexibility and minimise stocks is acknowledged, there is not an all-out directive to subcontract

[2]Surface-mount components are electronic components of various types that are mounted on the surface of a circuit-board rather than through holes in the board: this allows the same circuit to be set out on a much smaller board, but also requires greater precision in positioning the components and in printing the connecting tracks on the circuit-board.

everything. Printed circuit board (PCB) assembly and test, and final assembly and test, are to be retained in-house regardless. This leads on to a short but interesting section on core technologies which begins:

> *'There are no core technologies in the PTMC manufacturing activity. The core of the whole business is development.. ...test is the closest manufacturing gets to a core technology'*

The Strategy is rounded off with the Key Statistics section in Table 6.2

Table 6.2 Philips BCS Manufacturing Strategy - Key Statistics

	1988 Current Performance	*1990s Required Performance*
Production Value	£34.5m	£50m+
Number of Directs	400	300
Number of Indirects	150	140
Factory Stocks	£7m	£3m
Delivery Performance (Vol)	85%	98%
Delivery Performance (Item)	60%	95%
Throughput time	12 days	4 days
Absence	8%	4%
Engineering Changes	30/month	15/month
Process Yield - reject	5%	1%
Frozen Period Assy Schedule	12 weeks	6 weeks
Production Methodology	Batch	Flow

6.4 Development, Marketing and Sales

This section comprises descriptions of the three functions, other than manufacturing, most important to the present research. The first section, on the Development function, contains an extensive account of the new product development process. The second, on Marketing, concentrates on the organisation of that function and the views of some of its managers about the BCS business. The final section discusses the changes that have recently taken place in the Sales and Logistics activities.

6.4.1 Development

The Manufacturing Strategy document includes the following statement:

> *'There are no core technologies in the [BCS] manufacturing activity. The core of the whole business is development...'*

From the development director (a slightly less unbiased source, admittedly) came the view that development is 'at the heart of the business' and, furthermore, where there is conflict between the needs of development and the needs of manufacturing, development has a 'strategic mandate' to have its way. From the Organisation chart, it can be seen that there are only two directors amongst senior management - Finance and Development. When a set of organisation charts were provided, the order of the charts was:

Senior Management

Development

Accounts and Finance

Marketing

Personnel

Purchasing

Quality

Materials Management and IT

Manufacturing

At corporate level, the presence as consultant of Professor C.K. Prahalad with his emphasis on the 'New Product Creation Process' is also of note. If the BCS operation is to be understood then, an understanding of the development process is a priority.

The Development department has a matrix structure (Figure 6.7). The hardware group design the circuit-boards and components on them, plus other electrical fittings e.g. connectors and leads. The software engineers program the system functions. Finally, the mechanical group design the 'enclosure' that contains the functional hardware e.g. plastic moulded handset. These engineers are allocated to projects driven by the people on the other axis of the matrix - project managers. The Project Manager who had run the Sopho-S project was the first of the kind. Previously, as he recalled, there had been 'programme managers' who 'had no clout - they were more like minute-takers'. In the previous development facility, each functional group had occupied a separate floor on the building and 'the projects moved up and down the building'.

Project Managers were, in their new guise, 'much more directive in bringing the right people together and operating company-wide, taking in manufacturing considerations to a much greater extent'.

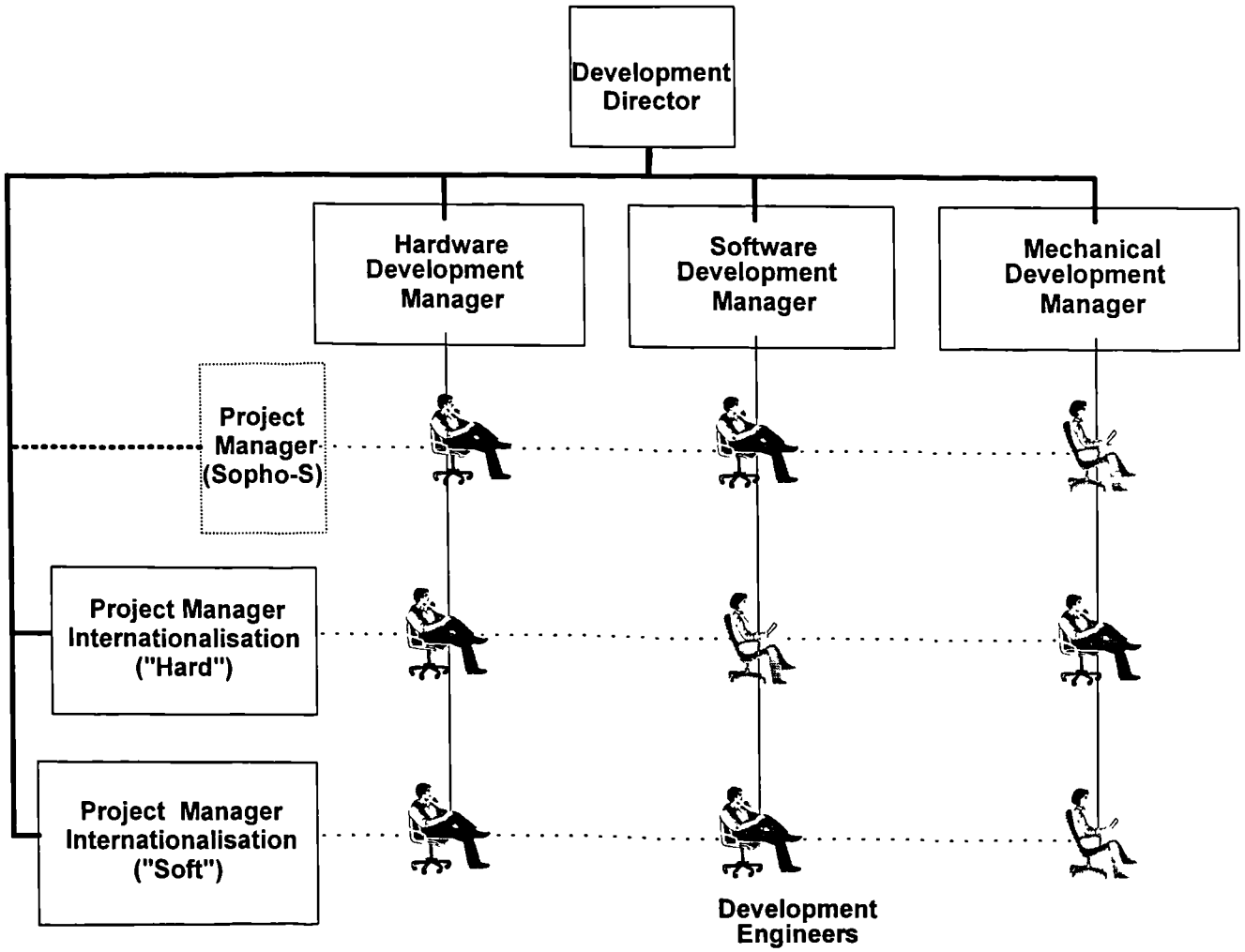


Figure 6.7 Development Department

6.4.1.1 The Development Process

A clearly staged development process is evident from interviews with development managers and from the documented plans for various projects. The generic staged

development process described by most managers were very similar to the process described on a publicity document emphasising the quality implications of a consistent and carefully controlled development cycle. This is shown in Table 6.3.

Table 6.3 Product Development Staged Process

Stage	*Output*
CONCEPT	Market User Requirement
FEASIBILITY	Product Technical Definition Spec
MAIN DEVELOPMENT	Stage 0 Design Review
FINAL DEVELOPMENT	Stage 1 Design Review
PILOT PRODUCTION	Design Release
FULL PRODUCTION	Customer Release
CUSTOMER SUPPORT	Field Analysis

Prior to the Definition Phase it is for the Product Marketing group to make a case for the project to be instigated, drawing on the necessary expertise as appropriate to the particular project, probably including the relevant software manager. Basic inputs to the discussion are: the 'broad' market requirement; functionality required; costing. There follows a review of the concept, the creation of an outline business case, and an estimate of the resources required to do a Feasibility Study. The Feasibility Study considers 'all the options' (according to one development manager), sets out the final market requirement and gives a 'reasonably clear' business plan.

It is from the Definition phase that the project is taken over by a Project Manager.

he Definition stage fully defines the product and the plan by which it will be developed. Then it's 'signed off and head-down into main development', with dates defined for the end of the project, internal release of product (for field trials) and external release (for sale). At the Definition stage, BCS are 'making some commitments to our salesmen.....it's for real now - we're starting to commit some money'. (All the quoted comments are from the same Development Manager.)

At this point in the account, the Development Manager halted the seamless description of the development activities and commented

> *'I must add, I'm taking a hardware/software/mechanical view in here, but on many projects, during concept and feasibility phase, the factory needs to be involved. I'm thinking multi-disciplinary, right?....and so it should be. Certainly as part of the feasibility report - and concept report - you need to look at the implications of what it is to make this product.'*

At various stages there are test and approvals hurdles to be jumped. The last of these before Internal Release is approval by the relevant PTT. This issue arose in a number of discussions about international variants and is clearly a crucial point in the project. This stage is 'not always easy - it may take months'. After Internal Release, pilot production can take place:

> *'where we can test that all the work that we've been doing through the main development cycle in terms of how we're going to test the factory processes er that gets tested in the form of a Pilot Build. I think that*

we don't spend enough time at the moment during main development to involve people from the factory in terms of saying 'how are you going to make this product? How are you going to be testing this product?' In many cases they don't even know what the product is that we're going to make, let alone what processes they're going to use for making it and what tools and infrastructure they're going to use for testing it. It's a big opportunity for us and, really, it has to be pulled from development because we're the ones who are making the product, who are designing it over here [the development department is on one side of the road, the production plant on the other]. *We need to pull people from across the road; we need to be more manufacturing- and test-orientated and say at the end of the day it's our product, and it's only as good as how well it can be made.'*

Following Pilot production, field-trialling with customers is possible. Given satisfactory progress with this, External Release is made. At that point, the design is frozen so, for example, the software is archived and changes can only take place through the release of a new version. Up until the External Release, the engineering change procedure can handle any changes that may be required. After External Release, changes are accumulated for the next version of the product.

The time taken to develop a product was difficult to determine. Because of recent improvements in the organisation of projects, it was difficult to estimate a 'typical' project length, but it was nonetheless estimated at 18 months 'from idea to pilot' for a big project - 'a new telephone'.

The complete life cycle in manufacturing varied. Two examples were given: a 'big

switch', the Pentara (one of the 'BT Products' in section 6.2.4), with a life of 7-10 years; and a 'mid-range' analogue switch typically planned with four enhancements, one every year, giving a total life of 5-6 years. Enhancements made later in the life-cycle were smaller, and achieved via software rather than hardware or mechanical changes.

Summing up, the Software Development Manager commented:

> *'Whenever you talk about the New Product Creation process, the first question that comes to mind is 'How does development and product marketing talk? How do they interact?'*

6.4.1.2 Design Review

The Definition stage results in an agreed product specification. According to the procedures manual, Design Reviews are:

> *'one of the most important tools for controlling and co-ordinating multi-disciplined project teams. Participation and interaction of team members leads to a comprehensive understanding of where the project is and what needs doing.'*

Product Reviews are carried out 'at any time from inception of the design until completion of Pilot Production'. and 'During Feasibility/Definition Phases these reviews may be called as required.' 'During the Development Phase these reviews

will be defined as in the project plan'. 'The composition of the Review Committee shall consist of members representing each function within the project. Membership shall include:

Function	Responsibility
Project Manager	Review Chairman
Product Marketing Manager	Market Requirements
Q.A.	Independent Auditor
Hardware Dev	)
Software Dev	)
Mech. Des.	)
Production	) as required
Strategic Purchasing	)
Logistics	)
Finance and Acctg	)
Customer Support	)

...Project Design Review Meetings shall be called by Project Management.'

The mandatory presence of Marketing sits uncomfortably beside the optional presence of Production and Purchasing. The role of Project Manager as indicated here may also go some way toward explaining one Production Manager's (presumably intentionally humorous) comment that Project Managers are broadly equivalent to mass murderers in their popularity within the production department.

6.4.1.3 Scale of Development Projects

Whilst the overall sequence of main stages is fairly straightforward in principle, there are many levels of product development. On the largest scale, there is the type of project that undertakes the development of an entirely new product concept - the Sopho-S for example. This was the biggest development project ever undertaken by BCS and cost some £6 million. This project and aspects of it will be discussed at some length in later sections.

Under the umbrella of a product family, there are smaller development projects. The simplest is that, within the range, there are different sizes of system, offering different numbers of telephone lines. So, whilst much of the work will be common to all sizes of system, there are a number of distinct 'models' of central unit for which the development must be carried through to completion. The original Product Plan, developed by marketing (see section 6.3.1), saw the Sopho-S being launched one size at a time, rather than all models at once.

Another level of development project relates to the creation of international variants. The spreading beyond the UK market has been a fundamental part of the Sopho-S programme overall, and each variant involves a greater or lesser amount of development work to provide a switch compatible with the territory in question. In particular, this involves modification to make the switch work with the existing external telecommunications system and, where appropriate, accommodate differences of language and convention e.g. customary dialling tones, system messages displayed

on liquid crystal display in the appropriate language.

A further level of development project is the upgrading of software version. This is the more frequent occurrence: for example, about two years after initial launch, the Sopho-S was on version 7 of the software. Managed correctly, this can represent an attractive after-market product, as BCS can sell updates to customers with systems installed previously. Versions are not developed for individual territories and, although release of versions will be staggered from territory to territory, any version will be the same in respect of features and functionality, regardless of territory.

Table 6.4 Scale of Development Projects

Scale of Project	*Characteristics*
'New Phone'	Entirely new range of switching systems. Large investment - several £m - and long project of 18 months to 2 years
Model	Within the 'New Phone', several sizes of Central Unit, several models of terminal
International Variant	Conversion, usually of all sizes of CU and most/all models of terminal, to suit new territory. Changes in software, territory-specific hardware and packaging.
Version	Of varying scale, upgrading of all sizes of CU and all models of terminal, independent of territory. Usually software improvement. Several versions per year.

These are the basic variables, identified from the inception of the Sopho-S, that necessitate a large number of development projects of varying scales. These project types are summarised in Table 6.4. Other unforeseen issues emerged, which complicated the task considerably: they are the subject of Section 6.6.

6.4.2 Product Marketing

The Product Marketing group was seen by its manager as dividing into three main areas: Product Management ('or preferably Product Marketing'); Business Development; Customer Support. Each of the Product Marketing Managers specialise by product group. An organisation chart is shown in Figure 6.8.

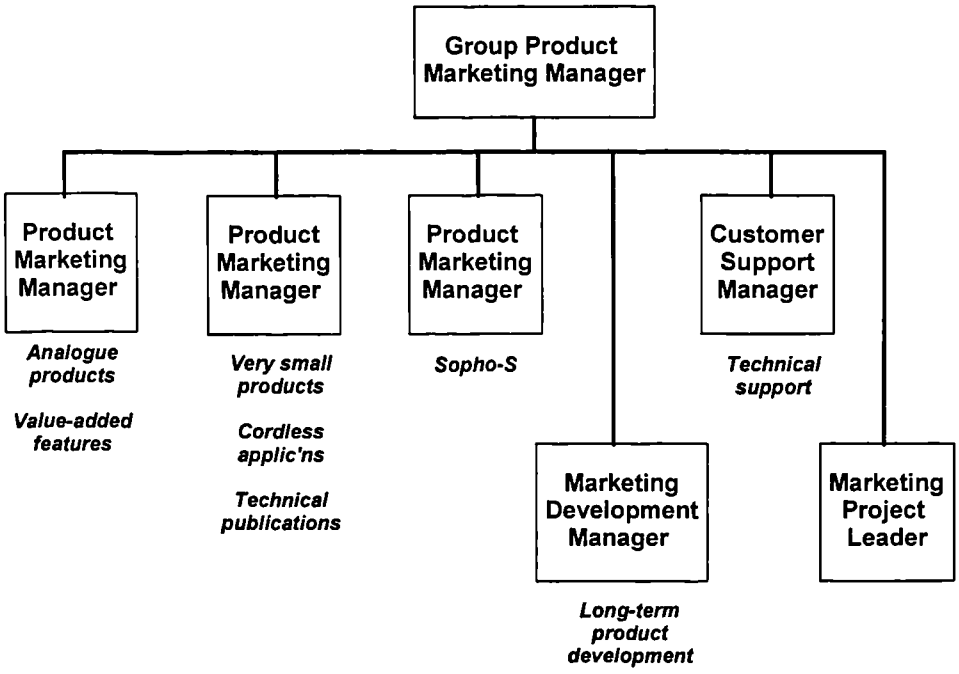


Figure 6.8 Product Marketing Organisation

The Group Manager commented that the Product Management activity, had traditionally been:

> *'a nuts and bolts type of activity - preparing specifications and relaying those specifications to our development group to produce products or update existing products'*

The past two years in particular had seen a greater emphasis on marketing activities:

> *'reaching out and trying to understand the customer requirements better by being involved in the marketing programmes for each of the product families.'*

This group also deal with marketing communications and technical guides. Business Development, 'alongside Product Management and a stage further back', is responsible for generating specifications for three to five years into the future. Finally, Customer Support is a technical support function, and the individuals specialise by geographical territory. Customers' first port of call for technical advice is the dealer (where appropriate); their second is the Philips National Sales Office (NSO) in their country; Airdrie Customer Support is the third level.

6.4.3 Sales and Logistics

Until relatively recently (18 months before the research period), there was a Sales function within marketing, with area managers and account managers (principally for British Telecom) reporting into the marketing hierarchy. The individual who is now Commercial and Forecasting Manager was part of that sales organisation. He and his role was brought under materials management and took on a 'new, factory-based emphasis'. Sales are now carried out by independent dealers, whose orders are managed by National Sales Organisations in their respective territories but, whereas NSOs used to hold inventory, this function has shifted to the Airdrie plant and NSOs

are now administrative rather than distributive.

The Development Director commented that a lot of money had been invested in these new channels. The change had also meant a loss of the high-quality market intelligence to which BCS had been accustomed from their established sales outlets, and this has resulted in very poor sales forecasting accuracy.

Coupled with the changes in Procurement (below), this has meant a significant move, at both ends of the supply chain, away from vertical integration.

6.5 Manufacturing and Procurement

Before describing the manufacturing organisation, plant layout and processes, and subsequently the procurement activity, it is important to describe the changes in the relationship between the 'make' and the 'buy' that have taken place in conjunction with the other changes - in products, markets and organisation, to name a few areas already discussed. In the days of producing 5000 telephones a day, the process was backward-integrated. For example, plastic injection-moulding of the body of the phone and handset were carried out by BCS (PTMC as it was then). Successive products have been bought in later in the sequence of operations. As an illustration, although by the time the Sopho-K was introduced, the injection moulding was subcontracted, the keys on a terminal keypad were still bought in separately and the keypad assembled at BCS; for the Sopho-S, the keypads are bought in not only ready-moulded, but also ready-assembled.

6.5.1 Manufacturing Organisation

As shown in Figure 6.9, the production management team is organised on functional lines - production, engineering, facilities and production engineering. At the time of the research, this was in the process of changing to a product-based organisation so that, for example, the engineering manager was formerly responsible for product support, customer service and repair and engineering change; he will gradually assume the role of Sopho-S 'Family' manager (in his terms), taking on responsibility

for production and production engineering insofar as they relate to 'his' products. Likewise the other production managers were to take on responsibility for other parts of the product range, with the exception of the production engineering manager, who will be responsible for the surface-mount process for all families requiring it.

As will become apparent, this follows the same principle as the layout of the production processes.

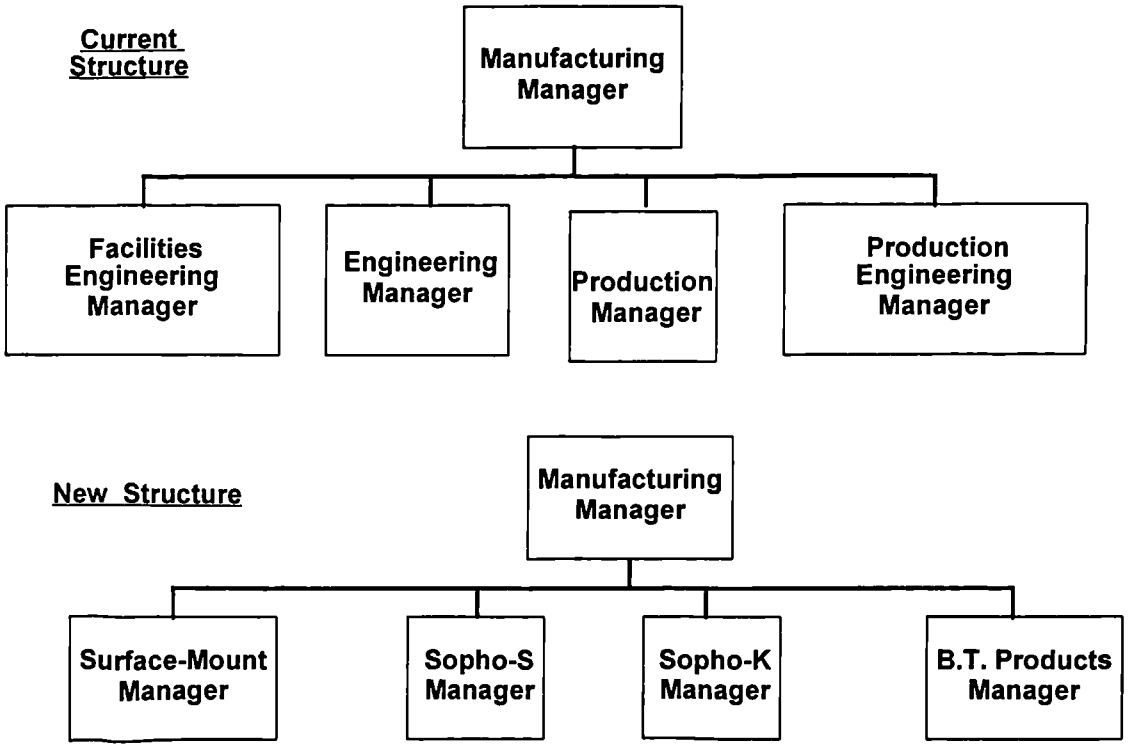


Figure 6.9 Manufacturing Organisation - Current and New

6.5.2 Manufacturing: Some Product and Process Technology Issues

Understanding some of the implications of this case depends on having a very basic grasp of some of the technological issues associated with products and processes. This is provided here.

Switching systems consist of Central Units (CUs) and Terminals. The Central Unit is the wall mounted `box' that does the switching and controls the communication with the outside world - the external exchange lines on one sire and the internal extension lines on the other. The terminals are the `phones' that sit on people's desks. These basic elements are shown schematically in Figure 6.10.

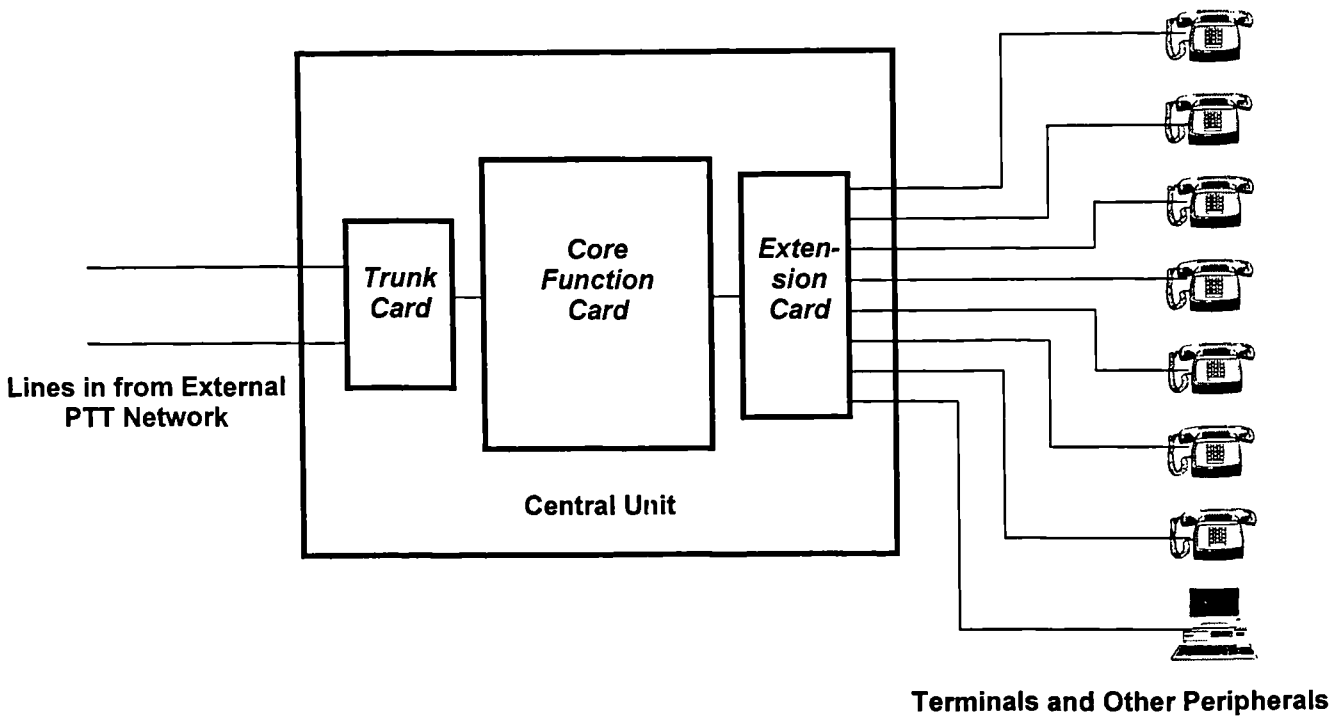


Figure 6.10 Schematic of a Small Switch

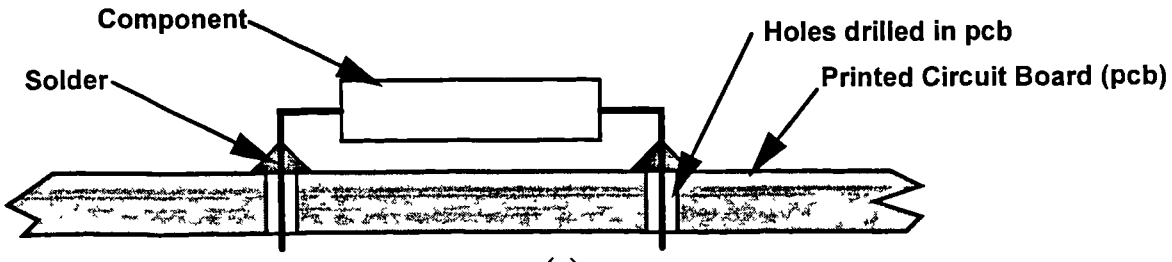
The functions of both parts of the system are achieved by electronic circuits consisting of various electrical components disposed on Printed Circuit Boards (PCB's). Another main part of the system is the `metal ware' that provides the structural frame for the mounting of PCBs and other components (power supply and connectors for example). The metal also performs a masking function, reducing interference of the system with the outside world, and vice versa. The next important group of components are the (mostly plastic) external components, notably of the terminals - the body, handset, key pads etc.

Each CU contains a number of PCBs, each serving a different purpose. One, the 'trunk card', transmits and receives signals to and from the external telephone line. Others provide the core functions of the system - switching itself, generation of tones, etc. Yet others provide (in some cases optional) functions with regard to communicating with internal extensions, computers and for example, CD players that provide 'musak' while callers wait for a reply.

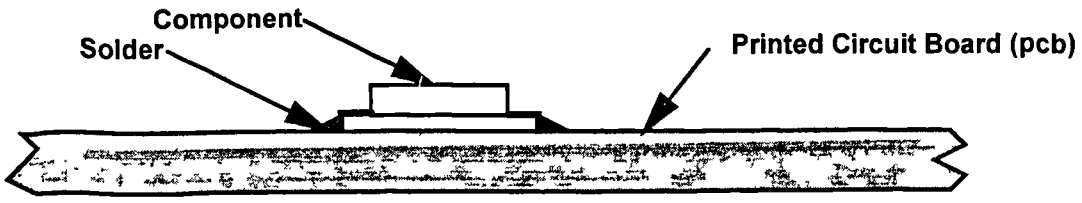
The functions provided by the circuits, as embodied on the PCBs, are achieved as a result of the design of the circuit and, in physical terms, by the various components on the boards. These are the `hardware' in the very BCS-specific use of the word. Further functions are provided by the programming of programmable components such as integrated circuits. The way these are programmed constitutes the `software'. Different functions may then be achieved by changing software, changing hardware, or a combination of the two. Changes in hardware might range from one resistor on a circuit board changing in value though to an extensive circuit redesign consisting

of different components and a different circuit layout. Hardware design has to provide the necessary functions but also provide ready means for the boards to be tested, both as free-standing boards and as assembled systems. Design-for-test is an important manufacturing issue.

The PCBs are screen-printed with conductive material in `tracks' that are the 'wiring' of the electronic circuit. These are very thin coatings as well as being increasingly narrow, as more components are fitted onto a given area of board. Components, such as resistors or integrated circuits, are then mounted on PCBs in one of two ways. They are either 'through-board' components with connectors that are inserted through holes in the PCB (Figure 6.11 a) or they are `surface-mount' components, which sit on the surface of the board (Figure 6.11 b).



(a)



(b)

Figure 6.11 Through-board (a) and Surface-Mount (b) Components

Because it eliminates the need for holes to be drilled in the circuit board, the surface-mount method offers the opportunity for components to be placed much closer to one another and hence the same circuit (functionally) to be created on a much smaller area. It is very attractive both as a way of making products physically smaller (or giving much more functionality in the same 'envelope') and of improving performance as currents have shorter distances to travel. From a process point of view, it cuts out the process of drilling holes in the PCB, but makes greater demands on the precision of screen-printing, board integrity, component placement and component fixing. Boards may have a combination of through-board, surface mounted and hand-mounted components.

6.5.3 The Manufacturing Processes

The three main manufacturing operations are board assembly & test, kitting and final assembly & test. These are shown in Figure 6.12. Board assembly involves some combination of the following stages.

Auto-Insert: placement of through-board components

Gluing: applying glue to one surface to temporarily fix SM components

SM Placement: positioning of SM components

Cure glue

Manual assembly: placement of bulky or delicate components

Solder Wave: solders components to board

Debridge & Extra Assembly: rework solder and mount heat-sensitive parts

Board testing: Circuit and or component testing on operator-set jigs.

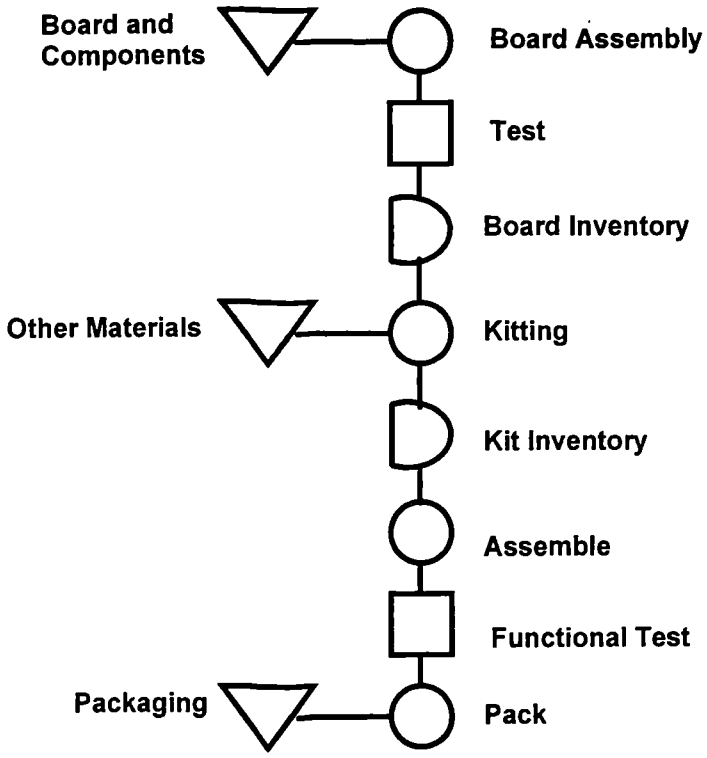


Figure 6.12 Outline of Manufacturing Process Stages

From observations, boards then sit in inventory at the end of the line. The exact process stages for board assembly will vary depending on the type of components required e.g. more recent design use less through-board and more SM components.

The approach used to provide the correct components for a given board are different in the case of through-boards as compared to SM. The through-board components are selected on a separate machine called a sequencer. This contains a large range of components from which it selects the necessary components for a particular board

and places them, in sequence, on a reel of adhesive tape. The requirements for any given board are taken from a sheet provided by the production engineering department, and the 'sequenced' reels are then brought to the insertion machine for the auto-insert operation.

The SM process is different. The SM placement machine contains a large number of reels, each of which carries one particular component. The heads on which these reels are placed then move to the placement station as directed by the board-specific program, loaded into the machine controller from floppy disk. The SM process thus cuts out the inventory of sequential reels and aims to offer considerable flexibility in terms of changing between one board specification and the next. The two operations are shown in Figure 6.13.

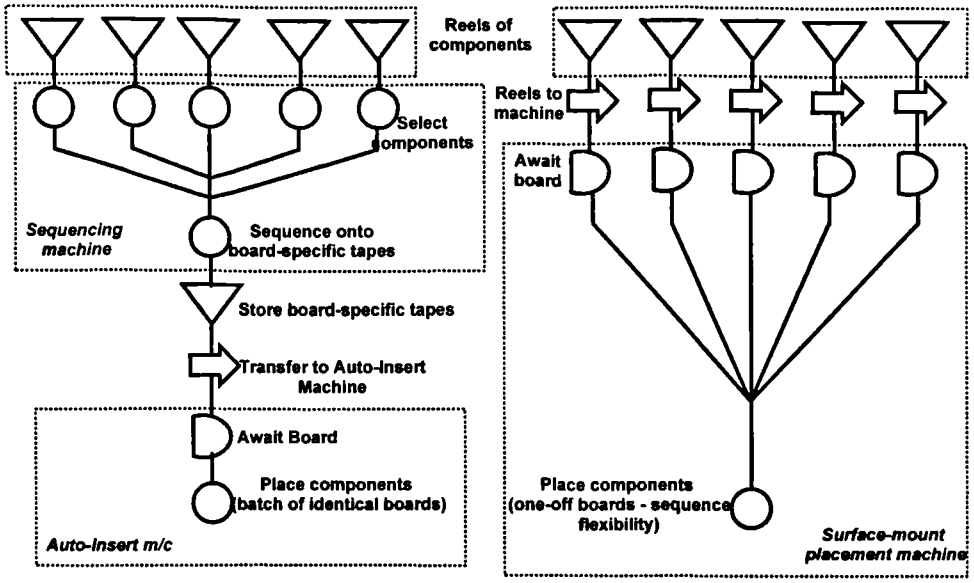


Figure 6.13 Board Population: Sequencing vs Surface-Mount Machines

The layout of the board assembly process is shown on Figure 6.14 as are the rest of the manufacturing stages. There are three Surface Mount lines. In theory, any product

could go on any line. In practice, they are dedicated to particular products: Line 1 to Sopho-K and Sopho-S Terminals; Line 2 to Digital Terminals; Line 3 to Sopho-S and 2+8 CUs. Typical throughput was estimated at 1000 boards per day (single-shift working), varying according to the mix of sizes. Batches might be 400-500 for small boards or 9 for large CU boards. For these particular boards, 9 was the minimum batch size and boards surplus to immediate requirements would be made for stock.

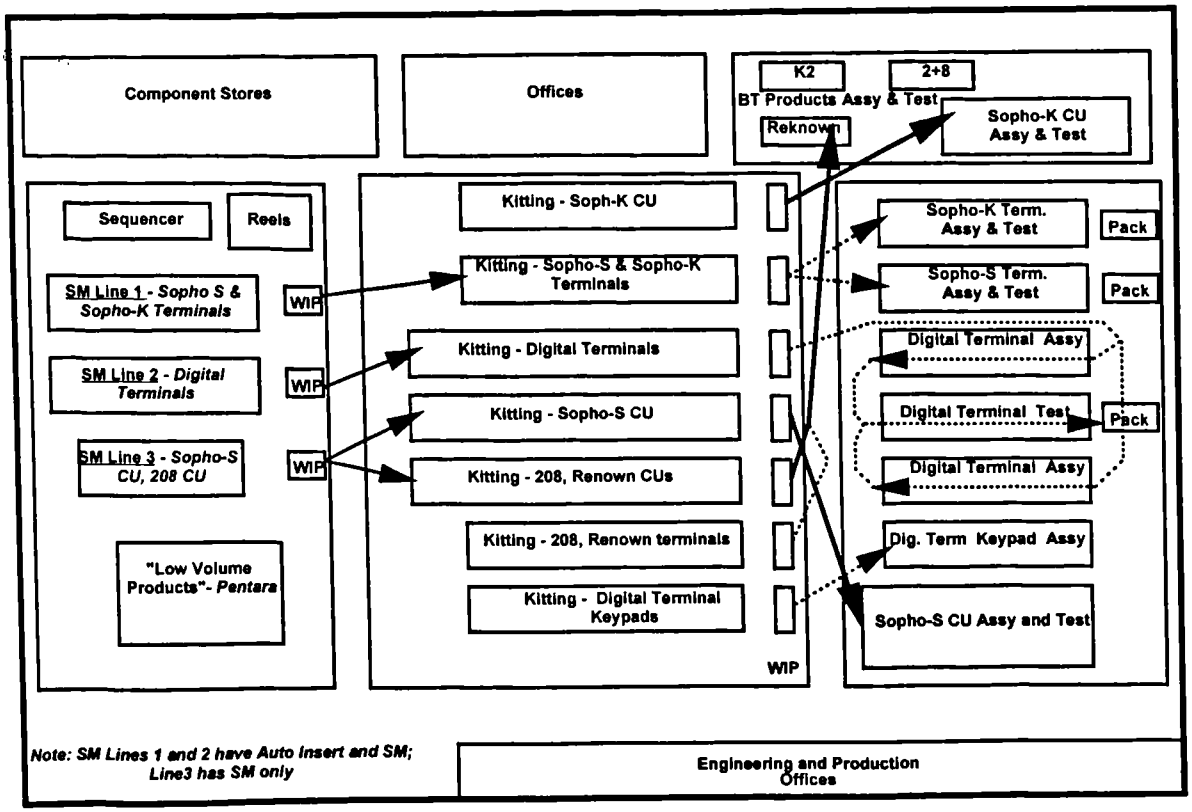


Figure 6.14 Plant Layout

The next stage in the process, kitting, is carried out on lines that are dedicated to specific products - in theory and practice - as shown on the layout. Work-in-progress, in the form of completed kits, was observed at the end of these kitting lines.

Most of the assembly lines are devoted to terminals. The CU assembly lines are split, with the older products, including some still made just for BT, being located out of the main flow of production, and the Sopho-S being positioned beside the terminal lines. Finally, there is an area given over to 'low-volume product', which seemed to be exclusively the Pentara switch for BT , in the process of being phased out. All the lines include various test operations and some have stations provided for fault-finding, where units failing test can be rectified. The product-based division of the assembly process is reflected in the new allocation of responsibilities to the production managers, moving as they are from functional specialism to product specialism.

The Sopho-S CU has presented new problems due to the number of assembly stages and its size and weight. A new type of purpose-built conveyor system was required, with several different jigs. According to the Production Superintendent, there are about 14 Sopho-S CU variants, and these are assembled in batches of nine or ten, amounting to a day's production. First-time yields on this product line were very poor - 17% - until a recent quality team project which resulted in 85% yields.

Testing, as shown in the Manufacturing Strategy, is a very important aspect of the process, and has become more complicated as the products have done the same. The purpose-built Sopho-S C.U. test equipment cost around £0.5m and involves the use of a computer more powerful than the VAX system used to run the firm's MRP system.

A very important element of the design-manufacturing relationship is design for test,

that is, the extent to which designers design products in such as way as to make testing easier. A stark contrast is drawn between the digital terminals and the Sopho-S terminals. The former were 'inherited' from the Dutch plant, where they were designed, and as a consequence the test process has had to be designed after the product design was fixed, resulting in three separate stages of testing. For the Sopho-S on the other hand, the product was designed with the test process in mind and so for these products, the same types of tests are carried out in one stage. There is an active programme of training courses, run by production engineering and attended by development engineers, on design-for-test.

6.5.4 Procurement

The Strategic Purchasing Manager reports directly to the General Manager of BCS Small Switching. This description of the department is based on an interview conducted with him.

The purchasing function underwent a structural change in 1989 (about the time of the PTMC Manufacturing and Purchasing Strategy). Prior to that, the now-Strategic Purchasing Manager was Materials Manager, responsible for the two activities of purchasing and materials supply, that is, for all contacts with suppliers, including the routine tasks such as scheduling and expediting. These latter tasks became the responsibility of the Logistics group within the Materials Management department and the Strategic Purchasing department was left to 'concentrate on the front-end' and

consider the longer-term issues. These include deciding which suppliers to work with, setting up supply agreements with them and designing and implementing supplier development. It also saw much more involvement in the buying-in of finished products e.g. the basic telephone, formerly the mainstay of the site, which is now made in China and 'badged' to 'complete the portfolio'.

Around the time of this change, the business had shifted from 80% of production being for British Telecom, to a much greater emphasis on small switching and internationalisation. For purchasing, this had the principal implication of changing the requirements:

'from high visibility, high volume, low variety to exactly the opposite'

The 'high visibility' refers to a very clear understanding and awareness of customer leadtimes. End-product variety for BT amounted to a choice from three colours. (Indeed, inspection of sales plans for the products still made for BT confirms this: one or two variants, with a year's firm orders for the same quantity every month.)

The production of the current ranges of switching systems, on the other hand, involves three sizes of CU, 5 different terminals, and there are twenty-two country variants. This was a shock for BCS's vendor base, as they also needed to shift to producing low volumes and high variety, often with a simultaneous big improvement in product specifications e.g. suppliers of printed circuit-boards had to change from what was described as 'punch & crunch' i.e. low specification boards to high grade

boards with fine tracks. There were also requirements for entirely new classes of parts e.g. sophisticated semi-conductor products.

The number of suppliers has reduced 'from around 400 to 142 and falling'. The contraction of operations has also seen a fall in purchasing power, from £20m annual spend to £12m (the period of comparison was not clear, but is assumed to be from the period of relatively steady-state activity with BT to the then-current year, 1993). Despite the proliferation of end-product variants however, the total number of different items purchased has not changed a great deal - standing at 2500-2800, with 1600-1800 typically on order at any one time. The practice of buying in at a higher level of the BOM has counteracted the effect of increased end-product variety.

Component technology 'has gone full circle'. The old TMC used to design and buy application-specific integrated circuits for telephones. Now there is a similar requirement, albeit with very much more sophisticated technology, for ASICs to go into digital switches. These are not Philips proprietary components though: for example, there is a generic 'ISDN ASIC' that performs the functions associated with the ISDN network standards. BCS accept the benefit from the 'industry volume experience curve' outweighs the cost of developing their own ASICs and that, as a consequence there is 'a level technological playing field' between Philips and their competitors as far as components are concerned. This was summed up with a guffaw: 'We're *not* leading-edge, ha, ha, ha'.

The strength of BCS was rather in system design - 'What does it do?' is the question

on the customer's mind. Winning orders also depends to some extent on the cost-to-function balance and will involve consideration by the customer of 'What do I do most?'. There will also be a concern with cost of ownership and, maybe, with so-called future-proofing i.e. buying a system that will be adaptable to changes in both the customer's requirements and telecommunications infrastructure technology. The criteria of delivery and quality are considered 'givens'. Formerly, a strong selling-point was installation (presumably when the sales force was much more closely-integrated with the rest of the firm). That is no longer the case.

The account of the Strategic Purchasing Manager was supplemented by an interview with one of his senior buyers, who was also quick to point out the shift to the 'strategic' role. This has meant that purchasing duties have fallen into two basic groups, to the extent that the working year is divided up into two parts, one devoted to each. The second half of the calendar year begins with the generation of the 'annual business figures' i.e. sales projections for BCS end-products. Based on this, and the required pricing and profits, a broad target is set for the cost of bought-in supplies. Based on this, the buyers negotiate with their respective suppliers to arrive at contracts for the following year for established materials and components. The first half of the year, by contrast, is given over to Product release and introduction. This involves working with development engineers and quality teams to identify suppliers for new requirements. The Senior Buyer was responsible for working with 65 suppliers supplying around 1000 items. All buyers specialised by commodity type, with some being more narrowly-specialised on technologically-complex items e.g. one buyer, termed a Commodity Specialist, concentrated on ASICs and other high-value

critical components.

This account also reflected the change in relationships with suppliers. Regular high-volume orders have been replaced by a need for supplier partnerships, with suppliers expected to provide a high level of service, quality and technical involvement, as well retaining competitive pricing. To illustrate the loss of high-volume orders, the example of user guide books was given: whereas for basic telephones, the order would be for one million identical guides per year, the supplier is now faced with supplying, for the Sopho-S, 40 000 UK old-style guides, 10 000 German and still lower volumes for several other territories. The price for these is lower than BCS paid for the telephone guides, despite the contents being much more complicated and the quantities being much smaller.

This has not happened without some disquiet. Early sales, and hence volumes to suppliers, fell short of projections and it is only with the rapid internationalisation programme that *aggregate* volumes have made the contracts a little more attractive to BCS suppliers.

The Senior Buyer was also able to give some information about the purchasing of such high-value items as ASICs and PCBs. These are bought not by BCS on their own, but by Philips CS as a group. CS will agree contracts with 'core vendors' for groups of such commodities, benefitting considerably from the purchasing power resulting from buying much higher volumes. This contrasts with the approach to buying more mundane items such as leads, where there has been a considerable

emphasis on using suppliers near to the BCS plant and foregoing any opportunity to buy across the group. It seems that the responsiveness of (possibly very distant) core vendors is still good, due to the purchasing power of Philips CS as a group.

Reflecting on the competitive issues of the BCS business, the Senior Buyer commented that 'as a purchasing man' he felt that the price of BCS products was the most important factor. Features are also important - not only what features are provided, but also that the user should understand what they are. As to delivery, reliability is also important, with examples being given of customers in the past having gone elsewhere 'regardless of increased price' following missed deliveries. BCS carry out benchmarking of their suppliers. The only example given was of packaging suppliers and it seems that the basis for comparison was price.

6.6 The Product-Range and Customisation

This section discusses the more specific concern of the research. First, the product-range as represented in the BCS marketing literature is outlined. The role of the products in terms of their overall contribution to volume, value and variety is then summarised, before concentrating on the new Sopho-S product. The remaining sections discuss customisation and some of the effects of increased variety on the shopfloor, with an emphasis again being placed on Sopho-S.

6.6.1 The Product-Range - A Clear View

Because selling products to customers other than PTTs - predominantly BT - is something relatively new for BCS, it is only for the recent products that widely distributed sales brochures are available. Two such brochures are reviewed here, one for Sopho-K and one for Sopho-S. In particular, the way in which the product range is set out will be examined.

Each of the two product groups is described in a similar way. There are two important issues - the system (or CU) and the terminals. The system parameters that are summarised are the number of exchange lines and the number of extensions. These are summarised in Tables 6.5 and 6.6.

Table 6.5 Sopho-K System Range

System	Exchange Lines	Extensions
308s	3	8
512s	5	12
824s	8	24

Table 6.6 Sopho-S System Range - 'Standard Configuration'

System	Exchange Lines	Digital Voice/Data Extensions	Supplementary Data Extensions
S15	6	20	8
S25	8	36	8
S35	14	50	22

In each case, a range of four terminals are also set out, varying in the functions offered. For each product group, all terminals are compatible with all systems. The features of both terminals and systems are summarised with extensive checklist tables that indicate which systems or terminals have which features. These checklists serve two purposes - one, to identify differences between the models and, two, to provide a basis for comparison with competitor products and/or the customer's requirements. In the case of the systems, the latter predominates, in that practically all the features are available for all the products: for Sopho-K, ten systems features are listed, of which nine are available in all models; for Sopho-S, fifty features are listed, five of which are 'optional', none of which depend on model i.e. all have all standard features and the possibility of all the optional features. In the case of terminals, there

is much more differentiation between models. Sopho-K terminals have 52 features listed, 18 of which vary between models; for Sopho-S there are 101 features, 49 of which vary.

On top of the basic choices of system and terminal, the Sopho-S literature offers a number of additional products. These include additional hardware that enable expansion of the number of extensions and communication with personal computers and other peripheral devices. This is consistent with the emphasis on flexibility and 'upgradeability' present in the Sopho-S literature: 'Feature-rich for today, future-proofed for tomorrow'.

6.6.2 The Product Range: Volumes, Variety and Revenues

The 1992 Sales/Activity Plan summarises on its front page the respective contributions to revenue of the principal product groups produced at BCS Airdrie. This is as follows (all sums in £m):

Total Sales Value	**22.3**
BT	4.7
Sopho-K	4.5
Sopho-S	2.6
Digital Terminals	10.1
Miscellaneous	0.3

This particular division of products for reporting purposes represents very well the transition BCS was going through i.e. from being a sub-contractor to BT toward having a broader range of activities. Not immediately apparent is the fact that, at the time, 80% of the 'Digital Terminals' business was for the German PTT, DBP. Despite the strategic shift away from volume telephone manufacture for BT then, (a) BT was still the largest single customer (they also buy some of the Sopho-K products) and (b) the next largest was also a PTT for whom BCS produced terminals in considerable volumes (250-300 per day in total, of which estimated 80 % for DBP).

Moving on from this overview, Table 6.8 summarises the volumes and number of variants within each of the product series. The data given relate to the 1993 calendar year and directly comparable figures are not available for previous years except for 1992. Rather than look for trends over time then, the emphasis here is on static comparison between the products in 1993.

In most series e.g. Sopho S and Sopho-K, there are different sizes of CU and different models of terminal. The data here aggregate all sizes and models and comparison is at the level of total CUs and total terminals. Accessories and options are not included. Data are taken from the 1993 Master Production Schedule. Variety figures refer to active variants, ie. excluding those on record but not produced yet.

Table 6.8 Products: Value Volume, Variety

Product Family	*Element*	*Value (£m)*	*Volume*	*Variety*	*Data Source*
BT	CU	2.53	23 224	2	Sales
	Terms	1.47	32 635	2	Sales
Digital Terminals	Terms	18.40	120 547	18	Sales
Sopho-K	CU	2.35	13 398	33	MPS
	Terms	1.73	25 987	42	MPS
Sopho-S	CU	1.86	2 238	30	MPS
	Terms	2.75	33 065	29	MPS

These data indicate that digital terminals represent a large proportion of the value, and are produced in higher volume than all the other terminals put together. Sopho-S CUs are the extreme case of high variety, low volume products, but Sopho-K have a higher variety of terminal than Sopho-S. Finally, 'BT' products are of extraordinarily low variety.

Even though from PCB assembly onwards, the products are assembled on dedicated lines, it can still be seen that the volume/variety differences between these products may well present problems.

Table 6.9 compares these for Sopho-K and Sopho-S to the sales plan of 1989, showing the extent to which sales have fallen short of the firm's expectations.

Table 6.9 Sales Comparisons in Thousands of Systems

	Plan (1989)		*Sales Report*	
Year	*Sopho-K*	*Sopho-S*	*Sopho-K*	*Sopho-S*
1989	13.6	0	no data	0
1990	33.2	0	no data	0
1991	45.2	3.8	no data	no data
1992	46.1	11.2	5.9	1.1
1993			13.4	2.2

6.6.3 Sopho-S

This section is devoted to the Sopho-S product. Although it is not the greatest contributor to the turnover of the plant, the Sopho-S range is in many ways important for its future. A good deal of management energy has been devoted to the range's introduction and this, combined with the alarming growth in variety within the range, made it a suitable focus for this research. The following sub-section will outline and quantify some of the plans that have been made for Sopho-S. The next sub-section will then examine the extent and some of the causes of high product variety within the Sopho-S range in particular. After that, the failure to implement a second generation of the range will be described and examined.

6.6.3.1 The Plan for Sopho S

To understand the shifting backcloth against which strategy has developed over the few years leading up to the research, it is instructive to examine the various views that have been adopted as to the nature of this business, particularly in volume and variety terms. A number of documents were consulted in relation to this:

Feasibility Study	Developed by Production Engineering in January 1988
Marketing Plan	Developed by Product Marketing Management in 1989 (see also section 6.3.1)
Manufacturing Proposals	Developed by 'Mechanical Engineering' (assumed to be part of Production) in July 1989
Actual and Planned Sales	Annual reports on achieved and planned sales - data available for 1992 (actual) and 1993 (planned)

The documents go into varying amounts of detail regarding the exact composition of sales e.g. volumes per *size* of system rather than just aggregate volume. For the time being, however, it is adequate to consider the aggregate data.

Table 6.10 Sales/Production Volumes of Sopho-S Systems Planned/Achieved

Year	Feasibility Study (1988)	Marketing Plan (1989)*	Manufacturing Proposals (July 1989)	Sales Report and Plan* (1992)
1989	4800	0		
1990	10100	0	2300	
1991	17000	3800	10100	no data
1992	27400	11200	16600	1051
1993			21000	2512
1994			26300	

** Note: These two documents refer to sales rather than production, so some lag would be expected between them and the related manufacturing plans i.e. due to building stock prior to launch.*

It is apparent from these data that the assumptions made about the timing of introduction and the extent and speed of scaling-up of volumes have been both very different to one another and (in all cases) a long way from what actually happened. The feasibility study and subsequent capital investment appraisal for process equipment were based on volumes between 10 and 20 times the achieved sales. It is difficult to understand how the Marketing Plan and the Manufacturing Proposal, documents both written in 1989, could have differed so much in their projections as to aggregate volumes. (Presumably there is not implicit in the difference between them a plan to make a year's stock in advance.)

6.6.3.2 Product Variety within the Sopho-S Range

The Feasibility Study and the Marketing Plan both set out programmes of internationalisation for the Sopho-S. They are shown in the tables below where, in each case, S,M and L stand for small, medium and large system launch or first production dates.

Territory	*1989*	*1990*	*1991*	*1992*
UK	L,M,S			
France		L,M,S		
Germany		L,M,S		

Figure 6.15 Launch Timetable for Sopho-S Given in Feasibility Study

	1991				*1992*			
Territory	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
UK	L	M,S						
France							S	M,L
Germany					S	M,L		
Italy			L	M,S				
Spain			S	M,L				
Netherlands					L	M,S		
Nordic			L	M,S				
Portugal					L	M,S		
Belgium					L	M,S		
Australia					L	M,S		

Figure 6.16 Launch Timetable for Sopho-S Given in Marketing Plan

Clearly the launch date had been pushed back by the time the Marketing Plan was written. As well as this change however, the projected variety had increased from three sizes in three territories to three sizes in ten territories. These data are only for CUs: there is a parallel proliferation in the number of terminals, although the majority of the territory-related differences in design are in the CU rather than the terminals.

The Sales Report for 1992 has sales activity for all three sizes of system in ten territories (although not exactly the same ones as in the Marketing Plan) and there were, in mid 1993, development projects approved, planned and in progress involving three more territories.

The number of territories is only part of the picture though. As previously discussed, versions of the software are changed, and other upgrades are sold. As a result of such factors, the March 1993 issue of the Master Production Schedule for 1993 has 13 small, 12 medium and 11 large central units. These include two variants for some territories and, interestingly, no variants of any size for the French market, which was one of the three European territories originally identified (UK, Germany, France).

The production consequences of the variants are far-reaching. The state of affairs envisaged originally was that, in simple terms, generic functions would be achieved by one or more PCBs, territory-specific functions relating to the external network would be provided by another PCB made specially for the territory, and a further special PCB would provide territory-specific functions for the *internal* lines i.e. extensions. The idea was that international variants would be made by substituting two

or three territory-specific cards and a few simple software changes within a standard assembly. The reality is that, for some territories in particular, the different requirements could not be satisfied in this way and that the differences had to go beyond the substitutable boards and into the generic components. Production engineering have found it necessary to unilaterally draw up a chart that shows which boards are used in which units. It lists 41 different Central Units. More detailed reasons for, and consequences of this are described in Section 6.6.5.

6.6.3.3 Sopho-S One-and-a-Half

The 1989 Market Plan identified a need for the Sopho-S product to move toward fully digital operation and ISDN compatibility. Whilst the Sopho-S as originally launched offered many of the benefits of ISDN and could rightly be termed 'fully ISDN', further development was envisaged. This was stated more explicitly in the 1989 Manufacturing Strategy, which graphically represented the succession of analogue switches (such as Sopho-K) by Sopho-S and then by 'Sopho-S-2'- see Figure 6.17

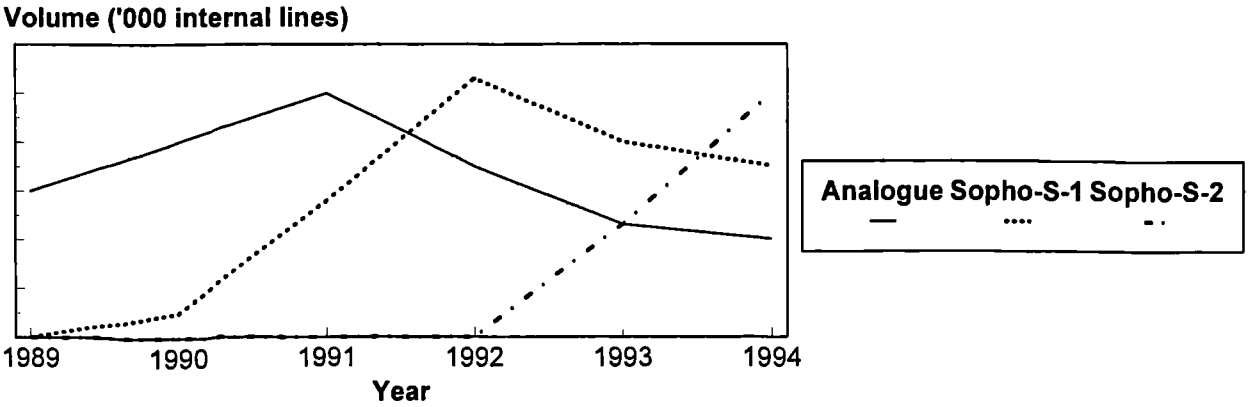


Figure 6.17 Product Succession Plan - Semi-Quantitative

Sopho-S-2 was to be a very clearly differentiated New Product, offering many more features and functions than Sopho-S, even after the original product had been subject to a series of software enhancements. As shown in Figure 6.17, Sopho-S was to be superseded as the premium digital small switch only two or three years after its launch. This distinctive product could command a significant price premium.

What had in fact emerged was what was known as 'Sopho-S-1.5' - perhaps ironically in the first instance, but subsequently termed as such by all departments in a matter-of fact manner. Sopho-S-1.5 was seen by the Manufacturing Manager as 'involving a lot of fuzzies' and representing a 'danger of falling into a fucking big hole'.

He joined the firm at the time when mock-ups of Sopho-S terminals were being made. The pivotal moment from which came the Sopho-S-1.5 was a huge meeting that took place in January 1989 to address, according to his recollection, the principal concern of the *high cost* of the original Sopho-S. This seems to have been a highly-charged occasion, going on for a whole day, and taking place in the context of a product release for the original Sopho-S that was a year and a half late.

By the admission of both Product Marketing and Development Managers, the original Sopho-S had been ill-conceived. The Sopho-S-2 was intended as the vehicle for embodying the first major software upgrade and changes resulting from market feedback post-launch. It would also enable use of more advanced componentry and manufacturing processes. These would combine to give the 'major stepping-stone' - a product clearly enhanced and bringing together a number of evolutionary

developments. This was not to be.

The original Sopho-S was found to be deficient in some markets, notably Germany and the Netherlands, in respect of its protection against interference. Secondly, there was a big underestimation of the memory requirement of certain functional upgrades that were required in some territories. Thirdly, the requirement for the Direct Dialling In (DDI) function was drastically underestimated and the part of the system providing that capability was inadequate. This pointed to the need for a fairly significant, reactive upgrade much earlier than had been planned. Indeed, the products launched into Germany were 'Sopho-S.1.5' from the start.

The upgrade to '1.5' involved changes in the CUs 'metalware': the mechanical structure on which PCBs are mounted and by which they are insulated from the outside world and *vice versa;* they also involved changes in electronic hardware and some connectors, as well as supposedly less-difficult changes in software. Sopho-S had been launched in some markets e.g. UK where requirements were less stringent and the differences due to unfamiliar external telecommunications networks were not a concern. Other markets necessitated the 1.5 platform. Thus the plant was faced with manufacturing international variants that had very different basic CUs - different metalware, different hardware, different software - rather than the original concept of dropping two or three territory-specific boards into a generic unit. Furthermore, there has subsequently been a process of introducing Sopho-S-1.5 units for the territories where original Sopho-S had been launched. For some territories, both types were in production at the same time.

The actual sequence of product releases was as shown in Table 6.11, where all sizes of systems are taken as being released together and the main variables are territories, software versions and 'platforms' (i.e. 1 or 1.5). (Some 1993 and all 1994 dates are planned rather than actual; platforms are 1.0 unless otherwise stated.)

Table 6.11 Release Timetable for Sopho-S Platforms, Versions and Territories

Year	1991	1992	1993	1994
Variants	UK v4	UK v5 Ger v5,1.5 NL v5 SWE v5 Port v5 Bel v5 Italy v5 Singap v4/v5 Spain v5	Ger v7, 1.5 NL v7, 1.5 Swe v7, 1.5 Bel v7, 1.5 Port v7, 1.5 Pol v7, 1.5 NZ v7 1.5 Italy v5, 1.5	UK v8, 1.5 Spa v7 1.5 International v8

A product marketing assistant issued a seven-page internal memo dated November 1991 to personnel, mostly from marketing and development, although also including the Production Engineer responsible for testing. Its purpose was to inform recipients of updates in part-numbers for Sopho-S products and the tabulated part numbers were preceded by a covering note that began:

> '*The list of [part numbers] for Sopho-S15/25/35* [i.e. S, M,L] *equipment has been updated (again!!) to include the following:.....*'

The changes in part numbers are just one symptom of a development programme that was always going to be fast-moving. The Development Manager identified three major

pieces of development work resulting from the '1.5' model. There were three issues of the 'trunk-card' - the PCB dealing with the external network - to improve the Direct-Dialling-In, call metering and other functions. The possibility of 4 or 5 issues of the trunk card was not discounted. There were also such oversights in the design of the central control PCB (the generic, territory-independent hardware) that the claims that the product was able to work with digital trunks was not wholly substantiated in practice. As these enhancement accumulate, the possibility of Sopho-S 1.75 was not discounted, although this may have been somewhat tongue-in-cheek.

Acknowledging these technical oversights on the part of Product Marketing and Development, the Manufacturing Manager also identified other change processes affecting the situation. Technological change bearing on the Sopho-S product was occurring in both market - the ISDN and related moves - and in manufacturing. He felt that 'Development forget this [second one]'. The changes in manufacturing technology i.e.process equipment were relatively slow. However, the changes in component technology - notably integrated circuits - were very fast. In this way, component technology was seen as taking over from customer/product requirements as the driver of change. That is, although the functionality required of a design upgrade may not necessitate the use of a significantly more powerful and miniaturised ASIC, such components may, in the period between upgrades, have become the new industry standard. As such, BCS are compelled to use components that demand new standards of assembly e.g. more precision in PCB tracks and component positioning on the board, even though the previous generation would offer adequate capabilities.

The difficulty then, is one of deciding when and how often to 'freeze' concepts - to accept a level of product and process technology despite knowing that they are obsolescent. From a marketing point-of-view as well, similar concerns were expressed. The Product Marketing Assistant, reflecting on the history of Sopho-S releases presented above, commented that 'management of succession is a really big issue'.

Ironically, one of the big changes that were the trigger for Sopho-S development, the move toward ISDN PTT systems, turned out to be much slower than anticipated. The Sopho-S was seen as the product that would be used for two or three years on the networks in transition between domestic analogue and international digital protocols, to be superseded by Sopho-S-2 which could be sold, at a premium, as a fully-digital ISDN switch to a market technologically desperate to reap the benefits of their new, sophisticated infrastructures. As it turns out, ISDN diffusion has been slower than expected, and uneven. Thus in Germany, the most advanced territory in ISDN implementation, the Sopho-S was inadequate from the start; in the territories slower with ISDN, many of the benefits of a digital switch still cannot be achieved. A notable consequence of this is that the first generation product - Sopho-S or Sopho-S-1.5 - needs to last longer, therefore there will be more versions. Also, losing the opportunity for what the Development Manager called a 'big splash' launch of Sopho-S-2 (which may never happen) and attendant opportunities for step-changes in price, the focus of the gaze on Sopho-S 1/1.5 shifts to generation of profit by cost reduction. Finally, noting the comments from earlier plans that the decline and withdrawal of Sopho-K will depend on the rate of adoption of Sopho-S, the plant will be faced with

producing both ranges for some time to come.

Sopho-K had been the first product to be internationalised and it is perhaps surprising that so many apparently simple mistakes had been made in designing the 'truly international' Sopho-S. Questioned along these lines, the Development Manager contended that some lessons had been learnt, but also agreed that some hadn't. Some of the Sopho-S territories were new, but BCS 'also closed our ears to Philips internal knowledge'. He also saw the Sopho-S as 'being positioned higher than the Sopho-K and you can't get away with things in the same way'. He felt that they had learnt: how to make an international trunk-card 'which was OK except for the Direct-Dialling-In problems'; they had coped with German differences via one card; and had prepared for a pan-European product (albeit that they had over-estimated the extent to which 'Europeans' would all want the same thing).

6.6.3.4 Internationalisation

Sopho-S was seen as an international product. As has been described, the scope and timing of this process has changed considerably during the life of the Sopho-S project. Also, there are varying views on how ambitious the intent was and/or should have been, and on what the motivation for internationalisation was at different stages in the project. A strong motivator for rapid and widespread internationalisation was the need to generate revenue to make up for the shortfall which had resulted from the misjudgment of small switch market characteristics and size, particularly in the UK.

Whatever the plan may have been, and whatever the motivation, considerable effort has been devoted to the process of developing and launching international variants. Three project managers oversaw this programme: at the time the research was being carried out, the project manager who had been responsible for the development of the Sopho-S overall was moving to other responsibilities; the remaining two managers were each responsible for internationalisation projects relating to particular geographical territories. For the reasons outlined above, certain territories - Germany was a notable example - had emerged as particularly demanding and problematic. These had become known as 'hard' territories, and one of the two managers was responsible for the small number of relatively complicated projects to develop the variants for these territories. The other manager was responsible for a larger number of so-called 'soft' territories, where technical and other requirements were not so far from what had gone before. According to the Development Director, there had been a need for 80 major new variants in 1992, and about 30 in 1993, 'to fill the factory'. The project manager for 'soft' territories provided a Gantt chart identifying ten separate projects taking place between June 1993 and January 1994. Durations of individual projects range from one to four months.

Whilst the distinction between hard and soft territories provides a potentially useful way of dividing the many trivial from the few significant projects, the distinction has not proved so easy to make. For example, Italy and the Netherlands had been classed as 'soft', but had involved extensive development work.

Evident in the whole internationalisation programme is the strong project management

culture. Detailed Gantt charts are developed for each project and responsibilities for each stage are allocated to the development engineers, in the context of the matrix structure previously described. For soft territory projects, most of the work relates to software and it is thus possible to allocate most of the stages to one individual within the software group.

Each project is initiated on the basis of a Business Plan, developed by Product Marketing Management. This has become a fairly routine process, with the basic components of any individual variant's Business Plan being clearly defined. The input data include projected market size (i.e.all sales, not just BCS), product mix by terminal/system combination, price levels, sales volumes for BCS and sales organisation costs. Output data are the volumes in number of lines (extensions), market share, plus financial measures - Turnover, margin, marketing and distribution costs.

However, in the one example business plan made available, many of the fields are blank - e.g. physical distribution and warranty costs are nil. Also, although the plan is supposed to reflect the development over three years, the only factor that changes year-to-year is sales volume - prices and all those costs that are reflected are constant. There are also some important data e.g. manufacturing cost and development cost which are not even required as part of the plan. Finally, the Business Plan treats the particular product variant in complete isolation from any others. The Business Plan appears then, to be a relatively simple conversion of bought-in market research data into notional volumes and revenues. There appears to be no explicit calculation of

profitability or return on the investment in development or manufacturing. There also appears to be no legitimation of the market share that is assumed.

6.6.4 Customisation

BCS do not customise products in the same way as some of the other firms considered in this research. They do not explicitly offer, in addition to a range of 'standard' products that customers can buy simply by ordering the relevant part numbers, the possibility of individual customers contacting, say, an applications engineer and having customised features added just for them. Systems such as Sopho-S can be configured in a range of ways once the equipment is purchased and, in this sense, are 'custom-built'. However, this only affects (a) the particular combination of terminals, CUs and accessories that are purchased and (b) the way the equipment is installed by the dealer i.e. it does not affect the factory except insofar as it determines the respective volumes of the individual system elements required.

That is not to say that products are not designed especially for individual customers. Clearly, products designed and made for BT have been the mainstays of the firm. These are, however, whole distinct series that are designed and made solely for the one large customer, rather than variations on a Philips-initiated range of 'standard' products. In many cases, BT own the designs.

This pattern is being broken. The Digital Terminals produced at Airdrie are supplied as Philips products in conjunction with the larger switching systems designed and made in Philips BCS Netherlands plant. A large proportion of these are sold to one customer - DBP - and customised variants are produced especially for this customer (see above for exact quantities). DBP have one of their QA Engineers in the Airdrie

plant for *one day per week* and specify quality standards more exacting than obtain for the rest of digital terminal production.

At the time of the research, negotiations to supply BT with the Sopho-S systems had reached an advanced stage and, assuming that these were concluded satisfactorily, it seems likely that BT would have both the purchasing power and peculiarity of requirements to buy customised systems in a similar way.

Aside from this, there is the question of internationalisation. Most of the special requirements for an international variant are functions of the particular infrastructure that exists in the territory and of the language spoken. However, there may also be particular requirement for features that are not offered elsewhere. Development strongly resist adding features as well as the changes that inevitably result from working in a different country. The division of labour between software engineers, for example, reflects this. It can be difficult, however, to draw the line between technological and linguistic necessity and cultural peculiarity. One simple example was that terminal handsets for the German market are made with a weight added because the standard design, being so economical of material, appears flimsy and unconvincing to the German hand.

Each new version - for all territories - is an opportunity to accommodate in the design trends in feedback from dealers and users. The difficulty - as perceived by the Manufacturing Manager - is to tell the 'difference between weird requests that are trends and weird requests that are just weird'. There is also the problem of

accommodating trends that may be divergent from one territory to another within what is supposed to be an international new version. This may mean building in many features that are redundant in most territories, thus using up CU power that could have been used for something else e.g. other features that are required, or faster operation.

Insofar as some territories only have one dealer, and Sopho-S products are effectively sold to dealers, this might be considered customisation. Certainly, in instances like this, the dealer will strongly influence the exact form of the international variant.

6.6.5 Shopfloor Effects of Product Variety

Whether termed customisation or not, the territory-specific differences certainly affect the shopfloor. New versions have been developed every year or so for most territories, and these versions offer opportunities to embody, for each territory, certain special requirements in terms of features. This is approaching the situation where dealers will be waiting for the release date of the next version, applying pressure for the features they have requested to be included, negotiating prices - in fact many of the things that a customer ordering a custom-designed product will do. Delivery - time-to-market - of the next version will depend on development time and priorities.

The original modular concept of the production and assembly process for Sopho-S CUs already described was to employ a 'card library', in which would be held small stocks of the territory-specific cards. The assembled unit would then have the relevant, territory-specific software copied into its memory and then be tested and shipped.

As the various shortcomings of the 'international design' became apparent (see 6.6.3.2, 6.6.3.3, 6.6.3.4), the effects of the differences in requirements went beyond what could be catered for in the substitutable boards and software alone. The 1.5 'metal ware' meant that some assemblies needed many more unique parts. More subtle but more insidious was the fact that some of the generic boards for CU platforms needed different components. This drew the point in the sequence of process stages at which parts - PCB s in this case - became dedicated to a particular end-product further forward, as indicated in Figure 6.19. Indeed, on one visit to the shopfloor a batch of PCBs was observed being loaded onto the very start of the circuit-board assembly process and, as the first operation, having certain holes on the board masked off with tape because the boards were for a particular territory variant. Thus, from that point onwards, they were only of any use for satisfying that territory's orders. Production planning of the exact mix of variants for territories then becomes a problem not just of making trunk and extension cards available in the 'library' in the correct volumes, but also of planning the correct mix of effectively territory-specific platforms. Different metalware is required for those CUs made to the 1.5 specification, so the vendor-scheduling task for these parts, to cite just an obvious example, is doubled.

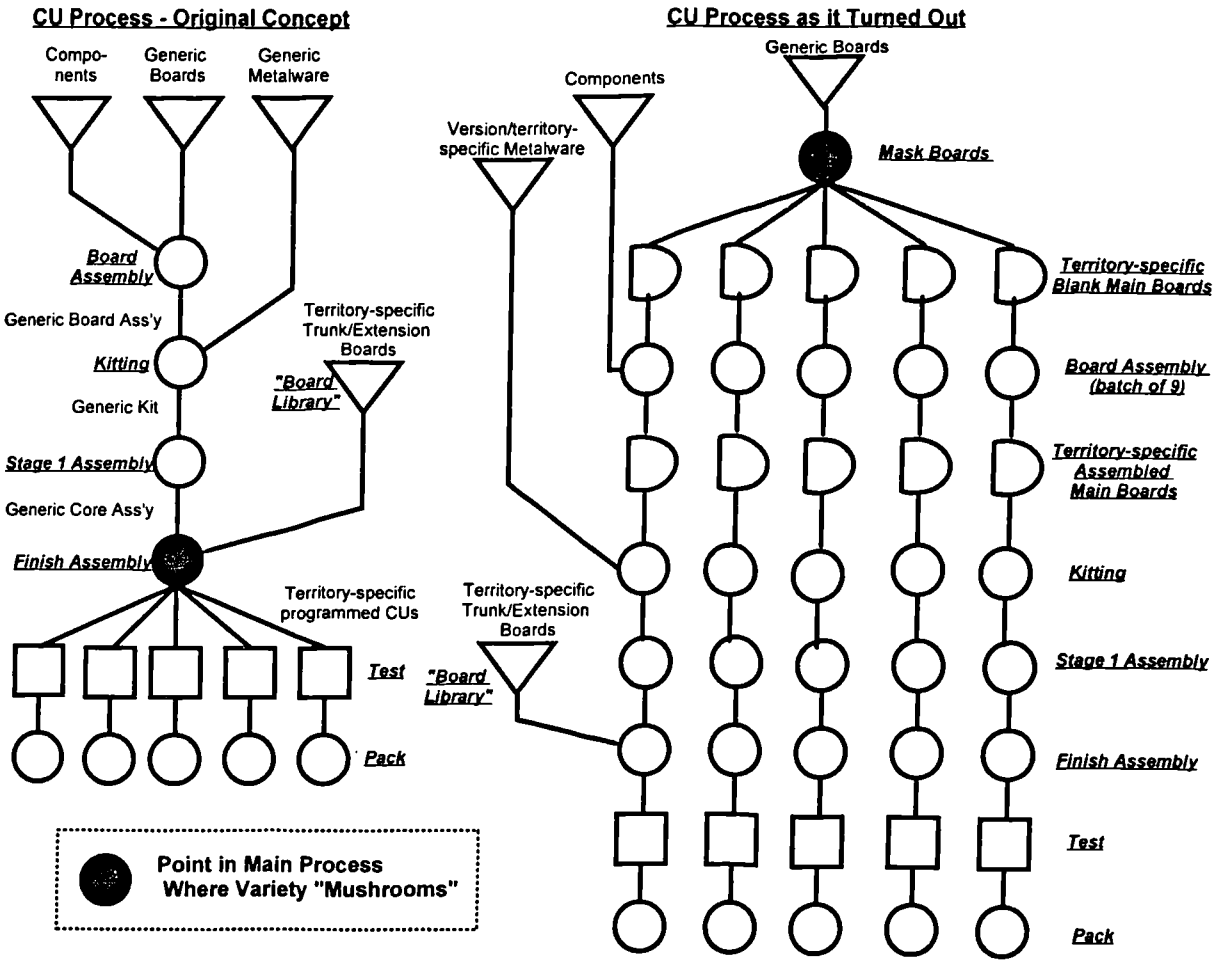


Figure 6.19 Sopho-S Central Unit Process - Intended and Actual

As well as committing WIP to specific variants early on, this means that a greater number of boards has to be catered for at the SM process. As described, the SM machine copes with sequences of different boards by holding a number of component magazines, of which only a fraction are required for any one board. However, as the number of different boards and with them the number of different components that might be needed on any one shift, proliferated, so the capacity of the machine to have available all the components was exceeded. As soon as this point was reached, flexibility of sequence was lost. Thus mixing production between two boards having

very similar componentry was easy, other combinations of boards having very different componentry to one another would require lengthy changeovers of magazines. The changes to the process, particularly the board-population stage, are illustrated in the process flow-charts of Figure 6.13.

A rough comparison of Bills of Materials for some variants gives an indication of the scale of the changes. A typical system has about 300 BOM items. Successive versions of the UK system involved changes to between 2 and 14 components - where a change is taken simply as either a different component or a different quantity of the same component. By comparison, the first version of the system for Italy (a so-called soft territory) involved 80 changes compared to the original UK system. The Italian system on a 1.5 platform had 140 changes compared to the original Italian system, and 206 compared to the most recent UK version i.e. something like *two thirds* of parts are either different or in different quantities. A Spanish variant on a 1.5 platform involved 119 changes from the original UK product. And these are 'soft' territories...

6.7 Case Analysis

As with other case chapters, the issues discussed here are those that are specific to or emerge particularly strongly from the case. Issues of a more general nature are developed further in Chapter 8.

6.7.1 Basis for Strategy

The simple fact that underlies many of the difficulties faced by BCS is that the market forecast for small switches upon which they based, amongst other things, their manufacturing strategy, was staggeringly inaccurate. It is something of cliché to say that forecasts are always wrong but, whilst it is one (fairly normal) thing for the actual sales to be 10% less than the forecast, it is quite another for them to be 10% *of* the forecast. The data presented in Section 6.6 show, first and foremost, how far short of any of the projections actual sales have been, for Sopho-K as well as for Sopho-S. They also show that it wasn't simply a matter of 'the company' forecasting one thing and reality turning out to be something different: even within 1989, the 'Manufacturing Proposal', which formed the basis for the capital investment for Sopho-S used very different forecast volumes to the Marketing Plan.

What is less easy to identify is why the forecast turned out to be (a) so bad in general and (b) to differ so much from one plan to another. One account gives the explanation that the degree to which BT's monopoly in the small switching market would be

eroded was misjudged. It is of interest to note that the Sopho-S products produced at Airdrie are only part of the whole Sopho-S range. The Hilversum production of larger systems - the range where PTT market share has apparently been more vulnerable - appears to have been more successful. Certainly they have been in a position to use Airdrie as a source of extra production capacity for terminals. It is provocative to speculate how much one basis for prediction of market size may have been used for all the products, large and small alike.

The shortfall in volumes, particularly of the Sopho-S but also of the Sopho-K, has contributed to many of the problems faced on the shop floor. Lacking revenue from these products, the incentive has been strong to prolong the life-cycles of older products. The 'Pentara' had been 'end-of-lifed' before, but then resuscitated. A firm with successful new products demanding all its available capacity might have fought harder to cease supply of products in decline; a firm in the position in which BCS found itself may be glad of revenue, whatever the source and whatever the (less obvious) cost in terms of loss of focus (Skinner, 1974). Before the proliferation of products within the Sopho-S series is considered, BCS was already producing more products and, perhaps more importantly, products with much greater differences in technology and process requirements than it had ever planned. Old products were retained; extra, high-volume products (digital terminals) were brought in; and all this was within a year or two of all the manufacturing processes being brought under one roof.

6.7.2 Interfunctional Relationships

Another reason posited for the appalling sales forecast is that, just at the time (i.e. when entering new markets with new products) when BCS needed all the high-quality market intelligence it could get, it cut off the very source of that intelligence by drastically restructuring its sales and marketing function. In particular it moved toward a dis-integrated distribution channel - dealers - as opposed to Philips' own sales staff. According to at least one account, there is little loyalty to Philips among dealers, so it seems likely that the provision of market intelligence for the long-term corporate good of BCS as a whole will be less of a priority than whatever activities will secure the good, long-term or otherwise, of the dealer. On the other hand, Philips will doubtless be glad not to be saddled with the problem of what to do with a corporate sales staff that would presumably have been greatly enlarged on the strength of the massively over-estimated size of the small switch market.

This example of interfunctional misalignment is by no means isolated. Most glaringly, the competitive priorities (Leong et al, 1989) or order-winners (Hill,1993), as identified in interviews with managers of various departments were very inconsistent:

Marketing management	unclear
Development	System design
Commercial	Availability and fast delivery
Logistics	Availability
Purchasing	Price

Sales	Price
Manufacturing	Unwilling to comment! (but: 'dealers are into features')

Meanwhile, there are some conflicting messages from Philips corporate, what with Professor Prahalad's 'New Product Creation' drive, and Jan Timmer's (head of Philips) personal hobby-horse about high utilisation of capital equipment.

6.7.3 Competitive Criteria 'Drift'

The differences in competitive criteria between functions is very startling. More subtle, but just as pertinent, is the shift in positioning and competitive emphasis over time (and here the focus of attention is the Sopho-S product). In the Market plan (1988/89) Sopho-S was to be a natural follow-on from Sopho-K as a 'No-nonsense, low-cost solution'. According to two other accounts, - one of the original Sopho-S project manager and one of the new Development Director - it was understood that BCS could not 'get away with things the way we did with Sopho-K' and, even more explicitly, that it was 'positioned higher'. Then, approaching launch, there was an inquest into ways to cost-reduce Sopho-S to make it viable. This change of tack may have been due to the realisation that the product, designed with high performance for PTTs in mind, was too expensive for the apparently more price-sensitive dealer channel to whom it was actually sold. The emergent strategy from then on has been one involving an attempt to generate revenue by a faster and wider proliferation of

international variants - for the range as a whole. Product variety has been used as a way to generate more orders, but potentially at the expense of other objectives.

6.7.4 Technology

BCS misjudged technology in two ways. Externally, it assumed that ISDN would be a reality (a) more quickly and (b) more consistently across territories than it in fact proved to. Internally, it overestimated the capacity of the systems it designed to tolerate inter-territory differences, particularly in respect of memory requirements.

The first of these misjudgments meant that the product life-cycle for the first generation of the Sopho-S product would be longer than expected and advance at rates more differentiated between territories than anticipated. The second one, combined with an under-estimation of inter-territory differences, led to the early need for a significant upgrade. Combined, they probably mean that three to five times as many variants than might have been anticipated will be produced in the lifetime of the product. And this, in its turn, combined with the gross shortfall in volumes, means that the volume of any one variant produced will be a few percent of the number it might have been and upon which the business justification for the original project and successive internationalisation projects were based.

6.7.5 Internationalisation

BCS had had some considerable experience of internationalising what was essentially a UK product - Sopho-K. The Sopho-S was to be a truly international product from the outset. Nonetheless, the underestimations of differences between markets both large and, in some cases, surprisingly naïve. As seems to emerge from the accounts, although designed as a 'truly international product' there was a very strong expectation that a large proportion of sales would be to BT. That may well have influenced the development standards and criteria and the outcome suggests that the best product comes from designing for the most demanding customer, rather than the most familiar. Although this was supposed to be a generic 'standard' product, there may well have been some 'closet customisation' taking place. This equivocation doubtless results from trying to design a truly international product in a firm that had never designed a product for anyone but BT.

Apart from this misjudgment, it is notable that no French product has ever been developed, despite France's being one of the three territories on which all the early sales and production plans were based.

6.7.6 Product Variety and Customisation

All the factors described in the previous sections 6.7.1-6.7.5 contribute to the volume/variety pattern, and the resulting manufacturing task (Skinner, 1969) being

so far from what was originally conceived as to be practically unrecognisable. As specifications for different territories, versions and platforms became more and more divergent, so shopfloor reality has moved away from the original elegant conception of generic hardware, 'board libraries' and territory-specific software to escalating variety in mother-boards, metalware and bought-in components. The point in the sequence of production operations from which central unit PCBs became dedicated to particular territories has gone back (upstream) just about as far as it can; production planning and control has become exceedingly complex and shop floor supervisors often don't use the MRP system for routine enquiries because it has become too slow - instead they use a variety of home-made ready-reckoners and aide-memoires, all of which run the risk of being out-of-date or plain wrong, in an attempt to keep abreast of which parts go in which unit.

The shortfall in volumes and hence sales revenues has spurred on marketing to identify yet more territories in which to launch the product. More territories mean more variety on the shop floor.

Interestingly, this kind of proliferation of variants would usually be associated with the mature or post-mature stage in a product's life-cycle. Here is a product in the growth stage of its life-cycle where rapid proliferation has been driven by, amongst other things, over-capitalisation of one firm's manufacturing system (and to some extent excessive sunk costs of a development project working to an inappropriate specification and over-running by a year?)

The reiteration and shared understanding of the Product Development Process, the basis for selection and justification of new product variants and the 'project management culture' has served to facilitate the introduction of each individual variant. In the Development Department, the combined effect of a number of product development projects in terms of the demands on engineers' time, is taken into account by the project management process. No such account appears to be taken, however, of the combined effect of a proliferating number of variants in manufacturing (except in vague strategic statements about 'flexibility'). For the purposes of capital investment appraisal at the concept and feasibility study of an international product variant project, it appears to be assumed that it will be the same to introduce a variant when it is one of forty in the plant as to do so for that same variant when it is one of five. It is, in reality, different to run a factory making forty variants than it is to run one making five; there is no 'rational' reason, as the project management machine trundles relentlessly on, for stopping any individual project from proceeding. There are though, many ways in which the systemic effect is undesirable.

extract..

It is worth summarising at this stage a few of the key factors that have contributed to the increase in product variety at the BCS plant.

1 Operations from the formerly separate switching and telephone factories were contracted first into two workshops on one site, then all in one workshop.

2. Despite withdrawal from volume telephone manufacture, digital terminals were brought in from Holland in addition to the small switching systems

3 Despite the introduction of new systems, notably Sopho-S, the life cycles of old products have been extended so that, at the time of the research, no switching system had been eliminated from the range.

4 Sopho-K products for n international territories had been progressively added.

5 Sopho-S products for international territories had been added, and at a rate faster than originally planned because initial sales projections had not been met and variants were used as a source of extra volume.

6 Unforeseen requirements for further variants had arisen due to technical oversights regarding (a) degree of difference between territories' requirements

and (b) extent to which generic hardware could provide these different requirements simply though software changes.

Chapter 7

Letts

7.1 Introduction

Charles Letts Group was, at the time of the study, a small, family-owned group involved primarily in the manufacture and sale of diaries to the business and retail markets. It also had interests in more general book publishing and manufacture.

7.1.1 Context of the Study

More than any other of the cases reported here, this case-study was carried out while the firm involved was undergoing major change, most of which was not anticipated (at least by the researcher) at the outset. In the end, the extent and rate of change, with the firm entering serious financial difficulties, led to a premature withdrawal from the fieldwork. Although then, in this sense, the case is incomplete, it nonetheless has provided a number of important insights that complement other cases.

In July 1992, Letts had two centres of activity in the UK: the production plant at Dalkeith, near Edinburgh, and the Central Management and Directorate in London. The latter included the Design and Marketing activities, the Publishing Division, as well as senior management. A sales force covering UK and overseas territories was managed from London.

The initial contact was made with the Dalkeith factory and, following a standard presentation on the concerns of the research, the Manufacturing Manager and

Personnel Manager were particularly interested by the marketing-manufacturing interface issue. The manufacturing activity was located in an unglamorous industrial estate in Scotland, where it had been for about twenty years following a decision to move manufacturing out of Fleet Street; Marketing had, less than a year previously, moved into 'Letts of London House', a well-appointed central London office which also accommodated senior management. It had previously been based in 'Diary House', another London office. In many ways then, the manufacturing management perceived a huge gulf between them and the marketing personnel.

However, even as the move from one London office to another was being consolidated, there was cause to regret the expense even of the new facilities. High interest rates and poor profitability left the firm in considerable financial difficulties. This, along with continuing concerns about the organisational dysfunctionality of the cultural and geographical separation of activities, and the unfortunate and unexpected death of the long-established Scottish Managing Director, led to an extreme restructuring of the firm during the course of the research. At the end of August 1992, a field trip was made to the London office to help understand the 'gulf'; by August 1993 the London office had been closed down, most of the staff no longer worked for Letts and a tiny fraction of the marketing staff (two Product Managers) had been moved to the Dalkeith plant. The running of the Dalkeith plant had been taken over by a new Managing Director placed by the financiers who had arranged the re-financing of the firm when its difficulties became too great to manage internally.

In retrospect, the whole research activity was coloured by the changing context. Although it was possible to collect some data early on, it is now apparent that the reluctance of some respondents to commit themselves was, to some extent, a product of their anticipation of and apprehension about some kind of major change. Particularly for some of the London-based staff, the changes that actually took place were probably greater than they ever could have anticipated. During the middle period, the winter and spring of 1992-1993, access was denied completely. By the summer of 1993, the firm's commitment to the research had clearly been superseded by other concerns and, although two more visits were made, cooperation was somewhat grudging and the visits were used to finally secure some quantitative data that had been promised many months previously, as well as to gauge the effects of the upheaval.

Having said all that, there are some substantive issues in the case that relate to other of the research concerns. In particular, Dalkeith manufacturing were concerned that the number of components was proliferating and that they were increasingly involved in making very small batches of customised products on process equipment unsuited to such tasks. As well as this concern at a detailed level with which business they were in, there had also been sorties into activities other than diaries and, as exposure to the firm went on, it seemed that there had been a continuing quest for the holy grail of a business activity that would overcome the inherent seasonality of making diaries.

The study will continue by describing that business in a little more detail.

7.2 The Diary Business - Markets and Issues

'It is basically a very simple offering'

This is how the London-based Product Manager summed up the diary business. And in many ways it is true. The appointments diary has existed in much the same form for over 250 years, since John Letts produced the first printed diary in 1812.

Letts divide the diary market into two: Retail and Special Editions. Retail diaries are sold through high-street outlets to the individual consumer, carrying either the Letts brand-name or, in the cases of larger retailers such as WH Smith, their own label. As well as a variety of essentially functional diaries, there are many designed for particular interest groups e.g. Scouting, fishing. Special Editions are sold to business customers, some of whom use diaries as gifts to their own customers i.e. the diaries function as marketing communications vehicles (indeed one respondent referred to Special Editions as 'Advertising Gifts'), and some of whom buy diaries for the use of members of their organisation e.g. a university. Whatever the use, Special Editions involve some content unique to the individual customer. Notably, there is practically no overlap between the two customer groups, although some hybrids are emerging e.g. the Piat d'Or wine diary, originally developed for the wine firm alone, has gone on sale as a retail product.

Seasonality is a major concern. Most customers, business or retail, would ideally like their diaries in October or November. (There are a few exceptions such as academic

year diaries for universities and the like.) Letts production plant has a considerable amount of capital equipment and permanent production labour and so could not operate a chase capacity strategy. It thus has to use a combination of demand management (largely via pricing), smoothing via inventory, and counter- or non-seasonal products. Customers are seen as buying 'slots' in the production schedule. Broadly speaking, the approach is to produce Retail products in advance of orders (i.e. to stock) early in the year, and to leave production capacity available later in the year for the largely unforecast Special Edition work.

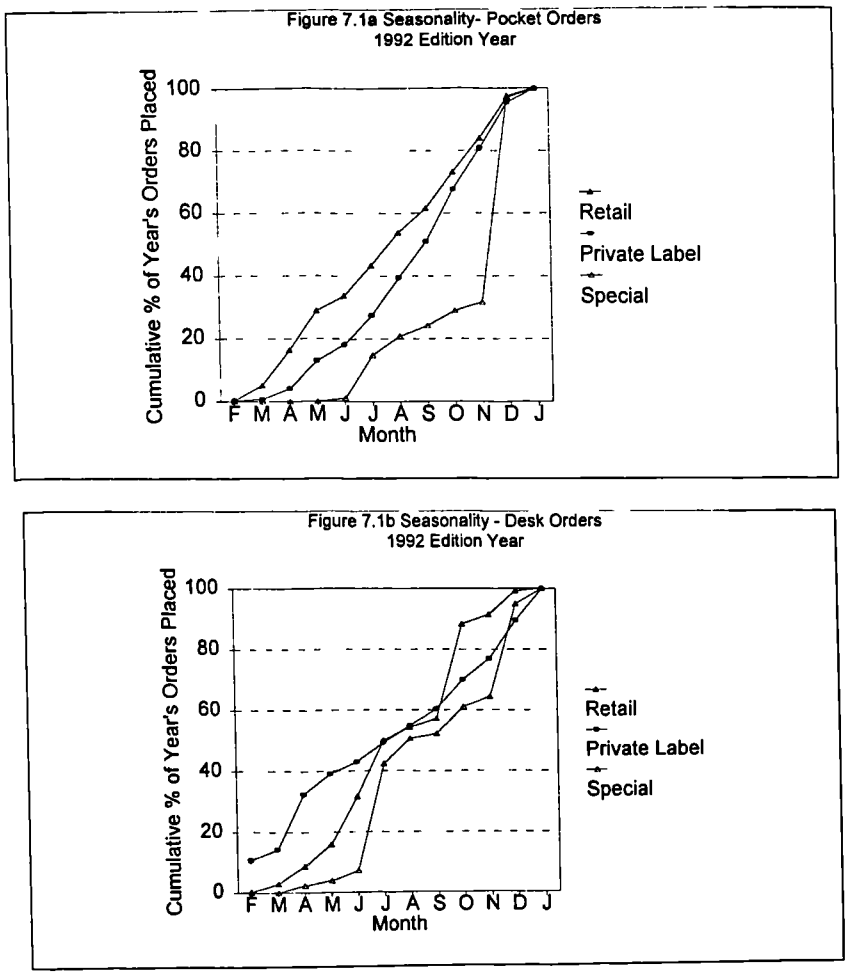


Figure 7.1 Seasonality of Order Placement (a) Pocket and (b) Desk Diaries

The graphs in Figure 7.1 are derived from data collected to confirm the seasonality. These show the timing of *order placement,* rather than *production,* for Retail, Private Label and Special Edition diaries in the broad size groupings of pocket and desk, commonly used in the information systems. For this, the 1992 Edition Year (i.e. produced during 1991), it is evident that, even by November, only 30% of eventual pocket orders, and only 60% of eventual desk orders for Special Editions had been placed. It is also apparent that even retailers were reluctant to commit until well on in the year - in both sizes only about half of the eventual total orders had been placed by July. This gives and indication of the extent of speculative, forecast-based production of Retail diaries that was necessary in the first part of the year, and of the peak in demand for Special Edition diaries in the last two months of the year. Comparable data at this high level of aggregation of actual production timing was not made available.

It has been noted that the customers for Special Editions and Retail are almost entirely separate. Furthermore, a number of interviews indicate that there is, among many Special Editions customers, relatively little loyalty between customer and supplier. Some large Special Editions customers invite a small number of suppliers to submit bids for the year's business in sealed envelopes and make their decision for the year based on the bids. The next year's requirements are satisfied by the same process, effectively taking little or no account of the previous year's transactions. From the other side of the selling process, Letts (increasingly) feel able to turn business away if it cannot be accommodated in the year's production schedule, apparently happy in the knowledge that the customers will come back the next year, offering Letts the

chance to supply them. The market is very concentrated, with one major UK competitor and some overseas competition (particularly affecting the overseas sales territories).

The importance of the diary purchase to the customer varies enormously. The large, identity-aware Special Editions client such as a major national utility will devote considerable effort to ensuring that the design of the diary is consistent with its marketing communications programme. This could well include selection of special papers and binding materials as well as the more routine inclusion of company-specific information in part of the diary. One client required a series of trials to achieve the correct colours and patterns in a spray-on marbling pattern on the edge of the diary pages. Toward the other end of the Special Editions spectrum, a lone purchasing agent in a small-to-medium sized firm may want an essentially standard product with a company logo embossed on the cover and a few pages of company information inserted at the start of the diary. The year's diaries are among the least of his or her concerns and, as one of the Letts Salesmen interviewed described, one of the most important issues here is that the specification and purchasing process is made as easy as possible for the customer.

In Retail markets too, there is a range of concerns. The large multiple retailer will make considerable demands in terms of delivery, product specifications, logistical and administrative arrangements. A small independent stationer on the other hand, will buy a few 'selection boxes' from the Letts salesperson when he or she phones or visits.

Private Labels - products produced for large multiples with their logo and sold through their retail outlets - are important, and increasingly so (although this will be qualified by the data presented later in the chapter). At the time of interviewing, 60% of retail business was with three customers; the business with WH Smith alone was worth about £1 million out of a total turnover for all diaries in the order of £22m. Here, the relationship is much less 'at arm's length' - the Product manager described Letts as being close to the customer and 'tight organisationally' with them. With customers such as WH Smith, the retailer's power was summed up in the archetypal conversation between Letts and the customer, which goes as follows: 'What do you want?.....Yes, of course!'.

A growing proportion of the Letts-branded retail business is in 'special interest' e.g. sports, scouting, wine. It was estimated as constituting 50% of non-own-label retail volume.

7.3 Strategy

This section will attempt to identify the strategy of Letts. First, the explicit strategy statements will be examined. Subsequently, such strategic directions as can be determined from marketing communications and interview data will be presented.

7.3.1 Explicit Strategy Statements

No written manufacturing strategy existed. It was clear from the original presentation to the manufacturing manager that the concept was not used in the firm, and that terms such as 'order-winner' were entirely new.

Letts does, however, have a broader statement of purpose for the firm:

> 'Mission Statement
>
> The Group's mission is to develop, as a family-controlled business, international markets for diaries, books and related products with a strong emphasis on brand, and to have a world-class manufacturing capability in high added value small book print/binding.' (April 1992)

Below this level, either documents did not exist, or access to them was not allowed. (For example, a 1991-92 Marketing Plan had been produced but, in the midst of speculation about individual and corporate futures, no-one was confident enough to allow its contents to be read or copied by an outsider.)

7.3.2 Marketing Communications

A wide range of marketing communications were examined, and it is evident that they are of a very high standard of design and presentation, in keeping with the Letts brand image and the need to communicate, through photographs, the appearance of the products.

There are many catalogues setting out the various ranges of retail products. Letts are explicit about their customised products: as discussed already, a separate sales force sells these to a more or less separate group of customers. As the emphasis here is on customisation, reproduced here is an extract from the leaflet covering the 'Bespoke Service for 1993'

> 'Our bespoke service means what it says. From cover to cover, the choice is yours....The only limit is your imagination....Personal service assures that products are tailored to meet your specific requirements and budget. Quantities start from as few as 100.'

7.3.3 Competitive Positioning

Letts, as can be determined from the Mission Statement and from comments made by many of the interviewees, do not see themselves as competing primarily on price. One

experienced salesman estimated that there were UK competitors with a 30% price advantage, and European competitors who were at a similar price level as Letts.

The Mission Statement emphasises the brand as an important criterion. To some extent, this is outside the scope of the manufacturing strategy focus of the present research, but cannot be totally divorced from more tangible concerns. For example, despite some evidence (as reported above) that customer loyalty year-to-year is limited, quality and service were cited by one salesman with an overseas territory as being particularly important to repeat business. This same salesman, whose territory included the Middle East, commented that 'features qualify you to talk about price'. In the Middle East, gold (coloured) features such as corners and page edges were particularly popular. In what is, as discussed, a relatively 'simple offering', small things count for a lot, and it is important that the corner reinforcements remain securely in place and the firm-specific papers inside are inserted in perfect alignment. The strength was seen as being in the basic diary - 'a focused offering for the English and Arabic market'.

The newly recruited UK Retail Sales Manager also put quality and service at the top of the list of competitive priorities. He also emphasised the need to find the correct price-point. Interestingly, he commented that customers were polarised between the loyal and the fickle, the latter being those in the 'mid-range' in terms of volume. At the time, Letts were exploring a new line of products - executive brassware. These were intended to complement the high-price executive desk-diaries and were simply being bought and sold on. It appears from the interview with the Retail Sales Manager

that, although these products were intended to exploit the existing distribution network and brand image, the reality was that in many selling situations a different buyer would be involved than would purchase diaries, and so it is debatable how much the brand would transfer between products.

Another categorisation of customers adopted by respondents in relation to Special Editions, was existing and new. One marketing manager felt that existing customers want service - many are very undemanding in terms of product innovation and simply require 'the same as last year'. New customers want more of a bespoke product and flexibility in terms of changing designs several times. This same manager agreed that the Letts brand was a strong asset, but that it had been 'tarnished by our service reputation'. Although most respondents played down the role of price, this same marketing manager emphasised that, particularly as Special Editions customers moved out of the prosperity of the late 1980s and into recession, the starting-point for many buyers was the budget that had been allocated for buying diaries, and price was becoming more of an issue than it had been in recent years.

One Sales Manager with an overseas sales territory commented on the importance of his being able to quote price and delivery at the time of meeting a potential customer. He was moving frequently from country to country and so it was difficult to go back several times to a client. As such, he had been given 'more discretion than most' in determining the price-ranges within which to quote. However, there were still some special requirements that necessitated an enquiry to Dalkeith and, if the relevant person or information were not available, considerable delay before a quotation could

be given. Bearing in mind the previously-discussed requirement to make the ordering process as easy as possible for buyers with other priorities, this could be a significant obstacle.

7.3.4 Manufacturing Strategy

There is no document, so far as could be determined, that might be called an explicit manufacturing strategy. The closest Letts come to this is in the supporting commentary on the Mission Statement. This defines the scope of their business in terms of products - '..diaries is our core business' - and in geographical terms, by a general emphasis on the international nature of the business. There is specific reference to having a 'World Class Manufacturing Capability', explained as follows:

> 'A world class manufacturer must use up-to-date technology and the latest management techniques. Management and workforce therefore have to have the information, knowledge and skills to apply these.'

The Mission Statement also includes a section on 'High Added Value Small Book Print/Binding':

> 'This is our particular manufacturing expertise. We must protect it through training and investment in the right equipment. We need to be highly efficient in our chosen field. We do not necessarily have to view

ourselves as general printers/binders capable of producing everything we can market.' (April 1992)

Here there is a concern with identifying scope - perhaps reflecting the concerns that the firm had been having in recent years about which aspects of its operation were essential and which weren't.

Manufacturing strategy in the sense of competitive priorities and volume/variety positioning are not explicitly addressed. However, a strong indication as to the implicit manufacturing strategy can be derived from the firm's adoption, with greater or lesser degrees of fervour on the part of individual members of staff, of Optimised Production Technology (OPT). A significant investment in management education had been made and, even at the start of the research, most of the manufacturing management were enthusiastic advocates. The most enthusiastic of all were the Financial Controller and the Systems Analyst, both of whom were located in Dalkeith but reported to the London-based Finance Director. After the major restructuring, the Systems Analyst was promoted and emerged as a major architect, or at least implementor, of the new regime. During the first phase of research, he had not been included in the Manufacturing Manager's list of potentially useful interviewees; after the restructuring, all paths led toward him. This section will therefore explain the approach at some length and comment on its strategic significance.

The most pervasive aspect of the change was the adoption of Throughput Accounting (TPA) techniques as a basis for decision-making. Until a year or so before, standard

costing had been used, with overhead allocated to individual products according to person-minutes of labour content. The factory was treated as a profit centre, selling to the sales group at some predetermined transfer price, which meant that cost to the sales group was entirely variable, and there was no incentive to favour, say, an order for twenty thousand of one item to an order for a thousand each of twenty different items, assuming the difference between selling price and transfer price to be the same in each case. The Binding operations are the bottleneck and, in keeping with the OPT principle of maximising flow through the bottleneck resource, the key measure of any order's viability under this new system is throughput per bindery minute (TP/bm), where throughput is simply the difference between revenue and material cost. The Sales commission is supposed to be based on throughput per bindery minute, rather than revenue.

(As already discussed, the centrality of this concept may not have been communicated too well to the sales force in that the newly-recruited Retail Sales Manager had never heard of TPA and the Middle East Sales Manager was introduced as being '£300 k ahead of his revenue budget', indicating what the *really* important measure might still be.)

The throughput measure was used as a demand-management device in the allocation of production capacity throughout the year. All other things being equal, the peak demand on production is in September and October, as diaries are made for delivery to the customer for the peak sales period of November and December. Demand management is achieved by setting differential levels of acceptable profitability - in

terms of throughput per bindery minute - depending on the time of year. According to this principle, the hurdle-rates might be:

Jan-Mar -	£1.50/bm
Apr-Jun -	£1.75/bm
Jul-Aug -	£2.00/bm
Sep-Oct -	£2.50/bm
Nov	£2.25/bm
Dec	£1.75/bm

(these are entirely fictitious)

Thus, a job for which the price obtainable would achieve a TP/bm of £2.10 would not be deemed profitable enough to justify the use of scarce capacity in September or October and the customer would have to accept early delivery (and early invoicing) in July or August or the business would be turned away. This serves to formalise the encouragement previously given to customers to take early deliveries but also, in using throughput as the measure, encourages longer runs, larger batches and better utilisation during peak demand periods.

Throughput Example

If TP = sales price - material cost = £0.50/unit, then TP/bm will be:

$$\frac{\text{£0.50 x volume}}{\text{(set up time + batch run time in bindery)}}$$

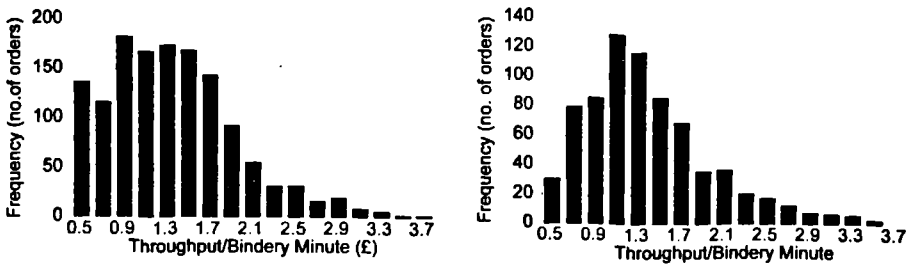
and TP/bm will be better for longer runs due to inclusion of set-up time in denominator.

The estimating section calculate TP/bm for all the estimates they do, and make a decision based on the hurdle-rate as to whether and what to quote for the particular job.

The principal set of quantitative data, acquired after considerable efforts of persuasion, is a database of orders accepted for two years: 1992 production and 1993 production. Although these data were censored, they still permit some assessment of whether the more serious and persistent implementation of the TPA-based hurdle-rates that took place between the two years had any effect on the amount of small unprofitable batches that were produced. The data-set could have been a research gold-mine in its original form in that, in that form, it could have indicated the relative importance of repeat as opposed to new business. But paranoia prevailed and a

condition of access to the volume/throughput data was that the identities of customers be removed and, with them, any prospect of making detailed longitudinal analyses.

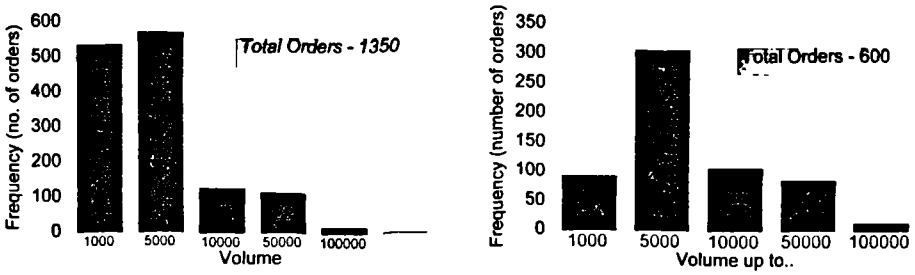
These data are presented graphically in Figures 7.2 and 7.3. The first graph shows the profile of orders placed during 1992 for 1993 use. These orders were accepted prior to the systematic categorisation outlined above. The second graph shows the orders that had been accepted at October 1993 for 1994 use. The analyst providing the data felt that they could be taken as more or less representing the complete production loading for this year although, if any of the skewing of ordering toward the last two months shown in Figure 7.1 prevailed, this may be a rash assumption. Making that assumption for the time being, two things are evident. First, the proportion of orders with low throughput per bindery minute - less than £1.00 - has been reduced considerably. Second, the total number of orders has been roughly halved.



(a) (b)

Figure 7.2 Throughput per Bindery Minute (a) 1993 Edition (b) 1994 Edition

The second pair of graphs shows the change in profile of volumes per item between the two data-sets. The proportion of low-volume orders has been very significantly reduced and, again, the total number of orders halved.



(a) (b)

Figure 7.3 Order Volume Profile (a) 1993 Edition (b) 1994 Edition

Table 7.1 Success of TP-based Filtering of Special Edition Orders, 1993-1994 Edition Years

Category based on 1993 Edition year	Number of orders	Number in each Category based on 1992 Edition Year				
		Cat 1	Cat 2	Cat 3	Cat 4	Not known
1	581 (89%)	Data not available				
2	20	9	8			3
3	12		**10**	**1**	**1**	
4	37			**32***	**3**	3

* These orders were consecutively numbered - possibly all for one customer.

This table indicates that only those orders in bold had been accepted in the knowledge that they had previously been of relatively poor profitability, and had stayed that way.

Only the 9 orders picked out with a double margin had been expected to be highly profitable and had turned out otherwise.

The tool that has been used to steer the manufacturing activities is rather technical and tactical, but the implications are of strategic significance. By implication, the TPA decision-making criteria have implemented a desire to increase volume and reduce variety. Seasonality complicates the issue, but the overall message is clear.

7.5 Organisation and Interfunctional Issues

This section outlines the organisation structure and then discusses the evidence for problems at the interface between marketing and manufacturing. It also discusses some of the measures that were being used to militate against these problems.

7.5.1 Organisation

At this point it is useful to consider a simplified organisation structure (Figure 7.4). This represents the structure when the research began. During the course of the work, at least two updated charts were provided and even then, these did not capture the situation at the end of the period i.e. after the closure of the London office and other divestments (see 7.8).

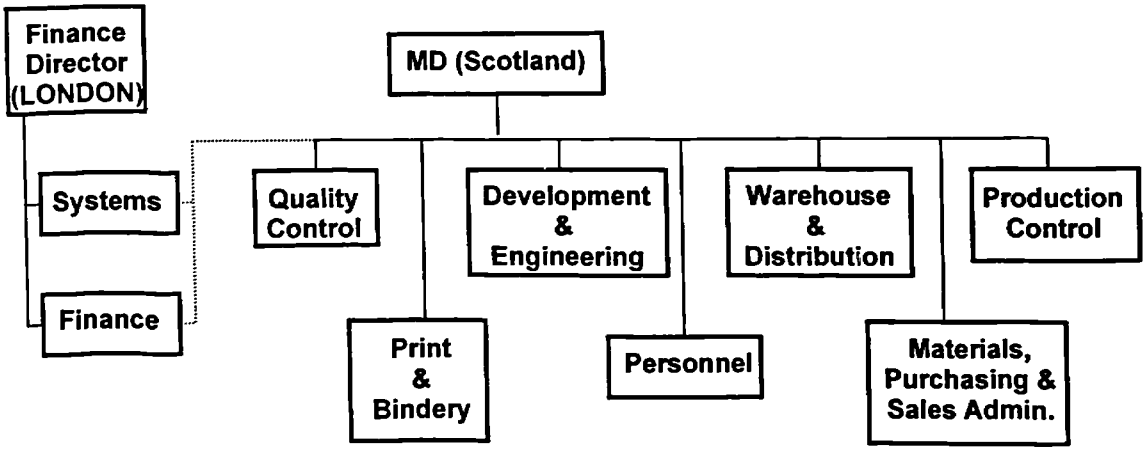


Figure 7.4 Letts Organisation at mid-1992

For a relatively small firm, the structure is remarkably complicated, particularly in London. Notable from the diagram is the existence of a Publishing division, which publishes and distributes travel guides, cookery books and, increasingly, a wide range of other titles. These are not printed in Dalkeith. Another offshoot is the Mayfair Trunks shop, which sells luggage and other prestige personal accessories. Another feature of the organisation is the large number of 'directors'. These persist at relatively low levels e.g. there are two so-called directors reporting to the Group Sales and marketing Director and a Sales and Marketing Director reporting to the Publishing Director. The Publishing Division comprises over 20 employees out of a combined London and Field sales Staff of about ninety.

The Dalkeith organisation has a fairly typical functional structure, with financial and systems activities, although located in Scotland, reporting to Head Office in London rather than to local management. Development and Engineering is almost entirely concerned with process development, hence it is naturally allied to the production plant.

7.5.2 Interfunctional Relationships

The poor interfunctional relationships, particularly between marketing and manufacturing, had been one of the starting-points for the case-study and these were soon confirmed. On the first visit made to the plant, it was possible to sit in on part of a newly-invoked weekly conference telephone call from Dalkeith to London. Every

Friday afternoon, the managers at Dalkeith were to talk over current problems and issues with the relevant marketing and other personnel in London. At that stage in the research process, much of the terminology was unfamiliar and the content of the call wasn't clear. At the same time, the London-based management were just about to start sending copies of the minutes of board meetings to the Dalkeith management. Both this and the new conference call apparently represented relatively radical steps. A later interview with the London-based Group Sales and Marketing Director characterised the interdivisional travel and communications as 'coming in fits and starts'. Visits from London to Scotland were 'either tours of inspection with clients or panic visits when there's a crisis'.

From the outset, the Dalkeith management who were supporting the case-study research were insistent that it should include a visit to the London office. They were more insistent on this matter than about any aspect of their own operation being examined. This sense of the researcher being used to some extent as fifth columnist continued as disagreement developed between the two units as to who was best placed to provide more detailed quantitative data. The initial gatekeeper was the Dalkeith-based Personnel Manager who appeared to have little influence over anyone in London and so, in the end, most requests were made directly to London. Requests for data in Dalkeith were referred to London; London staff either referred them back to Dalkeith, never provided the data due ostensibly to concerns about confidentiality, or referred the request to other individuals in the London office who were rarely or never available.

With the benefit of hindsight, it is clear that plenty of data were available ('information coming out of our ears', to quote the Product Manager) but that a major exercise was being undertaken in preparation for the restructuring. Some people had been involved in providing information for this exercise, some were merely aware that 'something was going on' and everyone was aware that it was commercially sensitive. So, whilst there was a genuine lack of understanding of the information systems that did exist in the 'opposite camp', a general reluctance to divulge details existed for various reasons and obfuscation was facilitated by lack of a very senior sponsor for the research and the almost limitless opportunities to refer enquiries somewhere else. Whilst to some extent this explains the lack of comprehensive quantitative data, it also *provides more data* about the state of affairs between the different parts of the organisation.

The cultural differences between the sites were clear and acknowledged by interviewees. Visits to the Dalkeith plant would, as often as not, begin with a fried egg roll and cup of instant coffee with the Personnel Manager in the Formica-clad works canteen. The visit to the London office, despite its brevity, was broken by an apparently inevitable long lunch at a local pizza restaurant. The conversation at Dalkeith would be about the latest restructuring or the difficulty in securing good apprentice printers; in London it was about recent or imminent business trips to Japan, and the horrors of commuting. The then-London-based Product Manager characterised the Dalkeith operation as having 'a Civil Service mentality' and claimed that 'we [Marketing] are the *doers*, they [Dalkeith] are the administrators and manufacturers'. An overheard telephone conversation reinforced this when the caller was informed

that '...our administration side is in Scotland...'

The backgrounds of employees in the two groups are very different. Many of the Dalkeith staff felt themselves to be in the book business; there is a strong tradition of training apprentices in printing, as demonstrated by the links with local colleges in furthering this type of training. One key informant, involved in cost estimating for prospective jobs, had previously been a printer on the shop floor; he commented on the lack of understanding demonstrated by many of the sales people in submitting details of specifications for new requirements. This was contrasted with a small area of activity known as Outside Sales which has sought to identify counter- or non-seasonal products (e.g. small bibles). The relationship with Outside Sales customers was so much easier, he felt, because these customers 'know books'.

The Marketing and Sales staff are recruited first and foremost for their ability in the sales area and many of the field sales people are from a Fast-Moving Consumer Goods (FMCG) background. A newly recruited National Retail Accounts Manager who was interviewed was a case in point: he had previously sold snack foods, cigarettes, hair-care products and car-leasing. His induction had included two days in Scotland during which he looked around the factory and met local sales representatives. Asked what his impression was of the factory, he responded 'big'. By this time in the research process, the use of Throughput Accounting (TPA) as a basis for deciding which work to do had been reiterated by many manufacturing staff; this particular sales manager had never heard of it. (This less evangelical opinion of TPA was echoed by the Group Sales and Marketing Director who felt it was 'linear

programming dressed up'.)

A key focus of interest for the manufacturing staff was reduction of 'piece-parts' (roughly equivalent to 'components') - indeed, one manager referred to the present research as 'your piece-part reduction project'. One senior respondent in the London-based marketing group questioned whether a lot of piece-parts was a problem or whether it was simply that the complexity was too much for poor systems.

7.5.3 Technical Coordination

Letts use a Technical Evaluation Committee to vet products that present production challenges. The Engineering Manager referred to this as the 'Technical Review Meeting system' and, in common with the Quality Manager, noted that products are put before these meetings *after the order for them is accepted.* Criteria for presentation are: estimates for orders with £30 000 or more revenue or firm orders with £15 000 or more revenue. The meeting, according to the Engineering Manager, involves the Bindery Manager, the Estimating Supervisor and the Engineering Manager himself. A third interviewee, the Warehouse and Distribution Manager, also referred to the 'ad hoc committee' which refines the production of special products, but 'this is mostly a vain attempt to make the best of a bad job *after* the undertaking has been given to manufacture the product'. A fourth manager referred to the committee as the 'Technical Clearance Committee'.

A further procedural device used to facilitate communications at the marketing-manufacturing interface is a document called, with the inevitable pun, 'Letts Make Your Own Diary'. This is intended for use by field sales so that they are aware of the more fundamental technical implications of choices they may make in designing a diary for a customer. It describes each operation and gives comments, sometimes in considerable detail, as to which operations present problems, or under which conditions each is most appropriate. It also includes specification ranges for each basic size of diary product. This had last been revised in 1990, and was identified by the Engineering Manager as a useful source for the present research. It was not possible to comprehensively assess the awareness of or use of this document among salespeople, but the newly-trained National Retail Sales manager had never heard of it, and the Middle East Sales Manager was somewhat dismissive: '.. field sale don't know, or need to know, details of the technical issues - it's not a complicated product'.

The Special Edition sales executive interviewed felt that Letts were still seen as specialists '...we can still do things that others can't or won't do, although I don't now if it's cost-effective. Things like small quantities and special materials, where we'll just get some [special material] in.' In the same conversation though, he commented that Manufacturing were not such a great asset, that 'there are plenty of printers around'; there were 'some good people at Dalkeith, but they are too compartmentalised'; and he too referred to the 'civil service mentality' that prevailed.

7.6 Operations

The focus will now shift to the operations involved in designing and producing diary products. The first area discussed will be design, then manufacture.

7.6.1 Design

By definition, the detail design of diaries changes every year. As well as this predictable change however, the period just prior to the research being carried out saw some other less predictable changes e.g. frequent up-dating of map sections as various countries (e.g. U.S.S.R) ceased to exist.

Particularly from a plant perspective, there is a continuous battle against proliferation of parts. The parts available from which to make a particular year's retail products is fixed approximately 18 months in advance; so, in August 1992, the parts list for the 1994 diaries, which will be made and sold during 1993, is 'frozen'. This is shown in Figure 7.5. At the time of the research, a weekly report of the number of parts was circulated among production management and a considerable (20%) reduction had been made on the previous year's number. Almost a third of the parts are the main diary portions. New Special Edition requirements added considerably to the part-count - 16% of parts were new Special Edition parts that had been added that year, and most of these were diary portions.

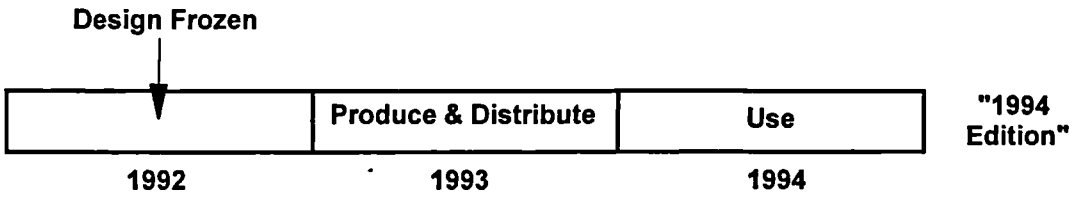


Figure 7.5 Design Leadtime for Retail Products

Although at plant level the emphasis is on designing individual diaries and on controlling part-count, the London-based Product Manager emphasised that the retail market was about selling ranges rather than individual products. The ranges were intended to provide 'something for everyone' and to 'avoid cherry-picking' on the part of customers. The key issue then, was to position the *ranges* rather than the items. The Product Manager acknowledged that this approach led to a larger number of products and acknowledged the potential conflict with manufacturing's desire for reduction in part count. In the end, the responsibility rested with him for the decision as to whether a new part should be added.

Design for Special Editions is a different matter. Not surprisingly, it is more reactive. The manager responsible for technical estimating identified two sorts of Special Edition jobs: 'specials' and 'special specials'. The sales force is encouraged as far as possible to build up special editions out of piece-parts approved for that year's production. 'Specials' are the type of product that, whilst they are unique to the client, they are made up from standard parts with just a company logo and a few pages of company-specific information added. Salespeople build up a price for these

from transfer price data they have on each component part. Customers may provide much of the unique copy themselves. This modular approach to pricing is used for quantities 'less than ten to fifteen thousand units'.

'Special specials' (or 'specials' in larger quantities) are subject to a formal Special Editions Estimate Request which the salesperson involved sends to the Special Editions Business Manager (in London), who then sends it to the Technical Estimating section (in Dalkeith). Once they have made their estimate, it is sent back to the representative via the Special Editions Business Manager. Typical turnaround was two to three weeks (although lack of access to data did not permit confirmation or quantification of this). If necessary, an important estimate could be done within a day.

The physical design changes and additions - to printed materials at any rate - is the responsibility of the Editorial and Design Supervisor. There is considerable liaison between him and the London-based Product Manager, particularly in determining each year's parts index and in obsoleting parts no longer required. Communications between Editorial and other parts of the Sales and Marketing group were described as poor, typically involving many iterations with long delays between stages, poorly-presented faxes and notes with information missing, illegible or wrong, and persistent difficulties in contacting salespeople due to their spending so much time 'on the road'.

7.6.2 Diary Manufacture

This account of production processes and equipment is based on interviews with (a) the Print and Bindery Manager and (b) the Development and Engineering Manager. The former was exceedingly unforthcoming and would return to a few basic comments such as 'we are market driven' and 'all the processes are fixed'. Again, this appeared to reflect considerable anxiety about impending change; in this case it was justifiable as, in the subsequent restructuring, the Print and Bindery Manager lost his job.

All diaries are produced in the same workshop. In very general terms, the process is as shown in Figure 7.6.

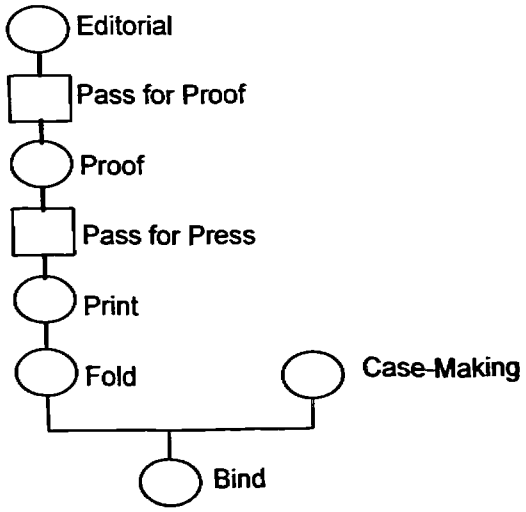


Figure 7.6 Process Stages

A number of process design issues are apparent. First of all, the constraint or bottleneck process is referred to by estimating and accounting as binding; notably, binding is used as the constraint in the Throughput Accounting approach to costing. Insofar as this covers a large number of process stages, it is a very broad statement. Another issue which seems to recur is the question of which of the bindery sub-processes should be in-line and which should be off-line. Some indications were given as to features which were becoming more popular e.g. sewn diaries as opposed to glued but, when asked, no one was able to definitively quantify how frequently each of the features were being asked for. Printing involves very long changeovers - both respondents quoted 50% downtime.

There is some consistency among respondents as to the features that Letts are good at. In particular, the strength within binding was felt to be in smaller product (pocket as opposed to desk diaries). In fact, most production processes are differentiated on the basis of size of product rather than type: so, for instance, standard retail pocket diaries and highly customised Special Edition pocket diaries would be cased-in on the same machine.

Other areas of process technology advantage were ribboning, gilding (both capability and capacity) and origination. In the latter area, a considerable capital investment had been made in computer-based editorial equipment. It is only relatively recently that the Editorial Department has been based in Dalkeith (since 1989). In very general terms, the printing equipment is relatively standard - 'printing is printing' - but many aspects of the bindery process are industry- or even company-specific. For example,

the ribboning machines have been developed by the Letts Development and Engineering Manager, as were the machines for applying metal corners (although these have become commonplace in the industry and no longer offer a competitive edge).

The Print and Bindery Manager was a little less discriminating in identifying areas of strength - he cited the Origination stage in general, the large printing presses and Bindery processes in general as giving a competitive edge, i.e. practically all processes. It is also notable that a strength in large-format printing is directly contrary to the perception expressed elsewhere that overall the strength of the processes was in the smaller pocket diaries.

Considerable importance is attached to procurement of materials. The Materials Manager has responsibility for Purchasing, Stock Control and 'Outside Sales' (the sub-contract printing and binding operation). The opinion of the Materials Manager was that Letts use much the same materials as their competitors and it was not materials *per se* that made the product distinctively a Letts diary, but a combination of materials, design and manufacturing. He was keen to stress that the emphasis was not on using the lowest-cost material, but on using appropriate material. The more demanding Special Editions customer will often require unique materials for their diary and, such can be the pressure for this, that the sales force are known to specify new materials with no prior consultation or pre-production trials - 'the first that the factory knows about it is that the material just turns up when manufacture is due..' This was confirmed by the London-based Product Manager who freely admitted that

Marketing will have 'parallel' communications with a potential supplier if needs be: 'I don't give a toss - manufacturing must work with us'.

7.7 Product Range

The lack of access to detailed data somewhat restricts the discussion of the product-range, particularly in respect of the relative volumes, revenues and costs of the different lines. However, the structure of the ranges can be examined.

One major dimension or distinction is that between standard and special and in this connection the Retail and Special Edition businesses have been described at some length. In between these is the so-called M-stock product, which is standard product made to stock and then superficially customised - usually this takes the form of an extra operation to add an embossed company logo or personalising initials. Also, as described, there are different degrees of 'special', and Special Editions that turn into Retail special interest products.

Other important classifying dimensions are size - desk or pocket in the broad sense, but there are variations in between - and basic functional characteristics such as week-to-a-page or day-to-a-page. Then there are various features which can be present or absent, such as maps.

There are then considerations of materials, colour and design (in the aesthetic sense).

Some Special Editions will utilise case materials from the Retail range, merely customising the contents and adding a different logo on the cover. Others may require entirely new case materials and colours.

In many senses, the diary has a modular design. Letts might be seen as having some competence in bringing the modules together in the binding process.

7.7.1 Volume and Variety

The categories used, the number of items, and the end of year volume (1991) were as shown in Table 7.2.

Table 7.2 Volume and Variety

Category	*Items*	*Volume (k)*	*Mean Vol/ item (k)*
Retail - pocket	141	1828	13
Retail - desk	143	3067	21
Private Label - pocket	75	582	8
Private Label - desk	116	1095	9
M-stock - desk	41	35	0.8
Special - pocket	381	780	2
Special - desk	200	297	1.5

7.8 After Restructuring

During a telephone call in February 1992 (about seven months after the initial contact) the reasons for the reluctance to accommodate visits or send data were explained by the Personnel Manager. They included the following:

- the management of the Diary business was to go to Dalkeith
- Diary sales and marketing were to go to Dalkeith
- the marketing department now consisted of two (formerly London-based) Product Managers
- the former diary Marketing Manager had moved into the Publishing Division
- the sales force would remain much the same.

This had, according to the Personnel Manager, been done for 'all the wrong reasons', i.e. that the old arrangement was 'unsustainable from an operating cost point-of-view'. Although less than forthcoming, the implication appeared to be that, although the immediate precipitating cause was financial, he would have liked a franker admission that the organisation was fundamentally dysfunctional, regardless of the cost implications.

During a subsequent follow-up visit, two interviews were carried out, and some quantitative data finally secured. The Product Manager, who had been a prime contact in London and was now based in Dalkeith, summarised the changes:

A Business Control Group had been established, with a prominent role given to the former systems analyst who had been promoted to Business Planning Manager. It had as a key objective to concentrate the business of profitable jobs. It had thus established four categories of Special Edition Order:

1 Win at all costs

2 Win

3 Review price

4 Lose at all costs

The previous year's Special Edition work were categorised along these lines according to the throughput per bindery minute they attracted. There were to be 'no loss-leaders'; they had 'dumped lots of own label' and stopped doing the sub-contract Outside Sales work altogether. An estimated quarter of work that had previously been Special Edition (i.e. involving original printed matter) had been redesigned as M-Stock (superficially customised standard product, printed and bound to stock rather than to order).

The newly-appointed Business Planning Manager was also interviewed. He expanded on the Special Edition categorisation exercise. The retail and M-stock work had been forecast based on previous years' patterns and scheduled in the year. Then all the previous year's Special Edition work had been evaluated along the TP/minute lines previously discussed, and TP/bm thresholds established. The working assumption was that, this year, all category 1 and 2 items would be repeated. This was intended to

give longer-term visibility over the whole year. Previously there was a sense (made apparent at the first visits) of 'seeing how things turned out' and, if at the end of December, the warehouse was empty, then it was probably OK. The Business Control Group was established as follows.

Membership included the Business Planning Manager, the Estimating Supervisor, Marketing, Customer Service Director, Sales Management (occasionally). No production management were included. This group met weekly to 'control the business plan'.

There was also a daily meeting, involving a subset of this group, to review each day's Special Edition orders and 'filter' them, according to the TP/minute threshold, to reject 'any order under 2000 unless there was a miracle' and to determine whether the required delivery date could be met in view of the practice of 'closing-off' production schedule periods. Requests not satisfying these conditions or involving technical features that were felt to be undesirable were referred back to the sales force with guidance to, depending on the circumstances, renegotiate or try to 'lose' the business. Anecdotal evidence of customers still placing orders after attempts to lose the business by massively increasing the quoted price indicate that Letts had not always understood their markets very well.

Of particular interest was that the Business Planning Manager was using a different macro categorisation of the product lines. Previously, the major division in the business was according to customer group - Retail and Special Edition. The sales

force was divided exactly along these lines. More than one manager had noted the growing importance of the 'Special Interest' retail products and the main change was to group these, for manufacturing information purposes, with Special Edition products, with which they share many production-related characteristics i.e. non-standard printed and other material. The diagram (Figure 7.7) shows the way that, before the restructuring, both Sales and Manufacturing Planning and Control was aligned with the Retail/Special Edition split in the actual products; afterwards, the alignment of the Manufacturing Planning and Control had changed to group products more according to common manufacturing aspects than to common sales channels.

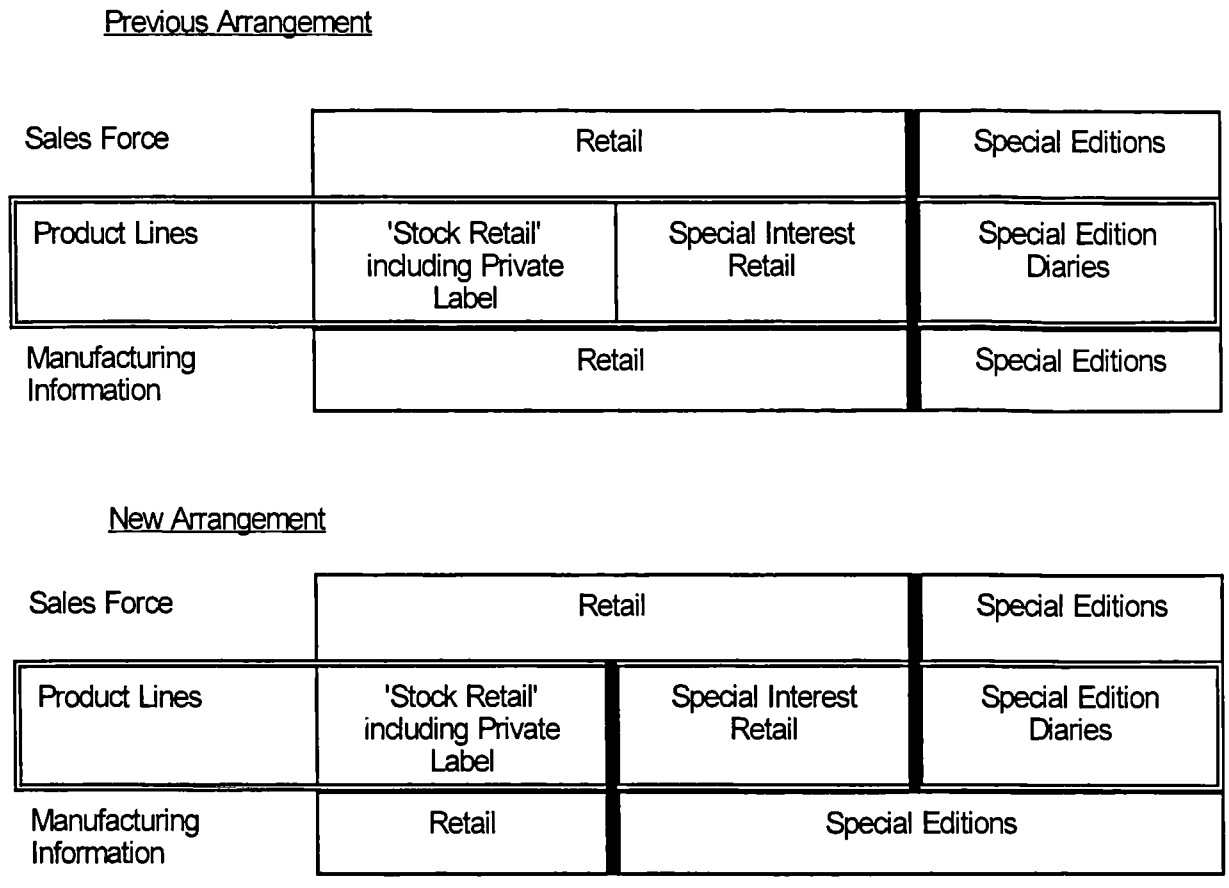


Figure 7.7 Alignments of Sale Organisation, Products and Manufacturing Information

The basis for more detailed presentation of data in the manufacturing information system reports had also changed significantly. Previously, every individual product item was tracked according to volume per calendar month. It was as though the firm were mesmerised by the seasonality of their business and that, by building up in ever greater detail a picture the precise nature of this seasonality, they felt that they could somehow manage it. This is perhaps connected with the salesforce concern with tracking their performance against revenue budget.

By contrast, the emphasis of the reports given as exemplars on the last visit to the plant were almost entirely concerned with throughput measures by size of product and by market segment (retail, special, private label, etc). Not one chart or table represented the seasonality of production or order entry; most of the charts analysed various parameters against diary size (at a much more detailed level than the pocket/desk split), which is directly related to the particular process technology to be used at each stage. The manufacturing information system was being used to identify, in terms related closely to quite detailed production process issues, which business was profitable (insofar as TP/bm indicates this). It was considerably easier to tell from the information which sizes made most profit, than which market segments. Whereas the previous focus had been on directing attention to the *market segments* that generated most *revenue*, the focus had switched to (albeit rather indirectly) which *production processes* made most *profit.*

In overall terms, this had contributed to a considerable shift toward the production of the smaller pocket diaries. Comparative volumes are:

Volumes('000 units)	Pocket	Desk	Total
1992 Edition Year	3190	4494	7684
1993 Edition Year	8621	3809	12430

and, although it wasn't possible to confirm this, the factory was reported to have eliminated overtime working during 1993, despite the considerable increase in total production volume. (These data are only for diaries, and it is not possible to say what capacity demands were made by other products e.g. the 'Outside Sales' sub-contract work.)

7.9 Case Analysis

In this final case, there has been so much change of various sorts during the research period that it is difficult to keep the central concerns of the research clearly in mind. It is useful to revisit the basic issues again.

As will be determined from the manufacturing-specific content of the Mission Statement, the issues of variety and volume, fundamental to a classical manufacturing strategy mission, are absent. The firm should be 'efficient', but there is no indication as to whether this is to be achieved by a low variety, high-volume approach. Also noticeably absent, even in a firm where customisation is an explicit policy rather than an emergent and apparently unavoidable evil, is any reference to the custom-design process.

There can be no suggestion that Letts are neglecting their manufacturing infrastructure - at least, some aspects of it. The adoption of Throughput Accounting and the associated production scheduling approach is as close as Letts come to a manufacturing strategy in the classical Skinnerian sense. Implicit in it (rather than emergent from it) is a move toward higher volumes and lower variety. The comparative data from the 1992 and 1993 edition years show this to have been effected.

Apart from this direct effect on volume and variety, TPA has arguably also acted as a useful vehicle for addressing problems at the interface between marketing and

manufacturing. Although the degree of passion with which the technique is advocated varies (perhaps not surprisingly, it is manufacturing personnel who are keenest on an approach which results in longer runs and less variety), it has provided a forum for facing up to short-term compromises between the two functions. It is notable that, although the Dalkeith personnel have generally been the most enthusiastic supporters, its implementation appears to have been driven hardest by two of the Dalkeith staff reporting to the London-based Finance Director. In that sense it has been centrally-coordinated.

In that the underlying assumption is that only material costs are variable in the short run, TPA is heavily skewed toward short-term considerations. But, to a certain extent, *any* explicit set of principles would have achieved some of the same results. TPA has initiated a debate about what the firm should and shouldn't do, and it appears to have changed this to some extent.

The interface between marketing and manufacturing was of paramount importance at the start of the project. To a certain extent, events overtook the research. But it is worth identifying some of the issues that existed, some that were addressed, and some that remain problematic. At the outset the polarisation between the two functions was stark in many dimensions (see over):

	Marketing	*Manufacturing*
Country	England	Scotland
Locale	City centre	Industrial estate
Accommodation	Well-appointed, stylish	Plain and functional
Organisation	Complex and Director-laden	Simple, functional
Business	Selling - anything	Books and printing
'Culture'	Street-wise?	'Civil service'

By the end of the research process, the first four of these had been eradicated, and there was an active process of attempting to address the last two. Moot points are (a) what the effect of the change will be on relations between marketing and *sales*, now that their priorities are no longer so obviously consistent with one another and (b) what the outcome will be of the business definition issue. There has been some considerable questioning about whether Letts should do *any* printing, in that most of the printing plant is old and inflexible, and the consensus view is that the firm's real manufacturing strength is in binding. Buying-in printing would leave the firm with much more diary-specific process equipment and shift the dominant technological culture away from 'printing and books'.

The atmosphere that prevailed at then end was one of crisis management. The newly-appointed Managing Director was 'running the firm like a receiver' and every small expenditure had to be justified. TPA was, so far as can be determined, concentrating efforts on the business that was more profitable in the short-term. It was not clear what strategic thinking was taking place, if any. Satisfying financiers week-to-week

was the priority.

One medium-term issue that seems to become more pertinent as the business shifts to fewer, but individually more significant customers, is that the loss of any one client year-to-year would represent a greater threat to the viability of the business than under previous circumstances. This would appear to necessitate more emphasis on managing relationships longitudinally, rather than 'screening' orders against Throughput thresholds come what may. There was some inconsistency among responses as to what proportion of business was repeat business and, unfortunately, no opportunity to determine this empirically.

Customisation of small production runs has been reduced by much greater use of M-stock. This is a fairly radical move from custom-design, make-to-order to standard production, make-to-stock, with a retrospective pseudo-customisation to-order. This has by-passed the custom-build, make-to-order stage that might have been the next option. Again, without empirical confirmation it is difficult to ascertain how readily customers changed from bespoke diaries to M-stock, although there was anecdotal evidence of smaller Special Edition customers for whom inertia was the main influence on buyer behaviour, particularly for relatively unimportant supplies like diaries. For such customers, all they really wanted was a diary that had their logo on the front that they could give away at Christmas.

It is apparent from the piece-part report that special editions add to the variety of printed parts, predominantly in respect of diary portions. So, special editions cause

increased variety in the most complicated and probably one of the most costly parts of the whole product and, furthermore, one which is produced on the process equipment (printing presses) with least product flexibility (long changeovers). In addition to this, printing is one of the earliest process stages. Prior to the restructuring, the responsibility for piece-part control was unclearly allocated - the Product Manager was supposed to authorise additions and deletions, but the quotation process for new Special Edition work involved the Special Editions Business Manager, who was apparently able to add parts if necessary and who worked for Special Edition Sales rather than for Group Marketing. Post-restructuring, it is not clear how piece-part control is to be carried out.

Chapter 8

Cross-Case Analysis: Strategy Content and Customisation

8.1 Introduction to Analysis

The case data comprising Chapters 4-7 inclusive have been presented in a sequence informed by the literature review, but not constrained by it. Some parts of the research were strongly informed by existing literature and constructs and so the collection of data and their presentation are, in the first instance at any rate, relatively straightforward. Other areas only emerged as concerns as the research proceeded. These issues may not be explicitly covered in the data-collection instrument and have been accommodated in writing the case Chapters in a flexible manner. Examples here might include the prominence given to product and process technology issues in the Philips BCS case, or the extended discussions of longitudinal factors in most of the cases. Each case chapter has included a preliminary analysis, capturing some of the issues particularly strongly-emergent from the case.

The approach to cross-case analysis is similarly flexible. This Chapter will be structured along similar lines to the Literature Review in Chapter 3, and the issues discussed there will provide starting points for each of the early sections. The approach is to assess which, if any, of the existing literature is most useful in understanding the data, then to identify significant emergent or contradictory data that may require an extension of, or modification to, existing theory. The analysis will begin by examining the theoretical topics in a relatively isolated way then, as the Chapter progresses, draw together theory that appears to have the most explanatory power in the three key areas of concern: manufacturing strategy, product customisation and the marketing-manufacturing interface.

8.2 Overview: The Firms, Their Plants, Their Problems

The firms studied all find themselves in difficult positions. The fieldwork was carried out in the UK, mostly in the middle of a widespread recession that had exposed problems that may have been of less concern in the more favourable economic climate that had prevailed a few years previously. Three of the four (Hyster-Yale, Honeywell and Letts) were all producing relatively mature products involving significant and apparently problematic customisation and product proliferation. The fourth, Philips BCS, was different in that it was producing brand new as well as mature products but, because of serious misjudgment of its markets, was facing very similar concerns with rapid product proliferation.

This section will briefly summarise the basic characteristics and demographics of the firms and the plants studied. There is no pretence that, from this we can infer that variables such as firm size or industry sector determine behaviour or outcomes. Each case is unique. These data will, however, serve as a shorthand by which to summarise the nature of the firms until more detail is set out in the sections that follow. Three of the firms are 'branch plants' of non-UK multinational manufacturers. The fourth is a UK-owned firm. All four serve industrial or business markets; one also serves retail markets. The following sections will describe and analyse relevant issues from the cases. For the time being, the basic data are summarised in Table 8.1.

Table 8.1 Summary of the Firms

Characteristic	Hyster-Yale	Honeywell	Philips BCS	Letts
Plant location	Central Scotland	Central Scotland	Central Scotland	Central Scotland
Employees on site	450 (380 plant/plant- support)	approx 300	Approx 400	approx 250
Turnover of plant	£60m	£14m (by transfer pricing)	£32 m sales value	£ 25 m
Principal product	Fork-lift trucks	Microswitches	Telephone switching systems	Diaries
Indicative customers	Industrial -manufacturing, transport etc. Europe, Africa	Industrial OEMs in various fields	PTTs e.g. BT; small businesses. UK, Eupope/global	Retailers - small and large; businesses. UK, and export
Other corporate activities	Other materials handling	Wide range of control products	Wide range of electrical and electronic interests.	Publishing
Other sites making related products	Yes. European sites, specialising by product size	Yes. US site- some overlap	Yes. Dutch plant makes larger versions.	Some production in US for US Markets
Support activities on site	Engineering, Sales Admin, Applications	Marketing, Engineering, Distribution centre	Development, production engineering	Production Eng, Customer Service*
Distribution	Independent sole dealers	Company sales force with pseudo-market relationship	Independent dealers	Letts sales force
Principal product technologies	Fabricated steel. hydraulics, electrical control	Electromechanical and solid state switching	Microprocessor-based electronic circuits	Paper, inks, binding materials
Principal process technologies	Fabrication, welding, machining of steel; fitting	(for AOM products) Manual assembly, welding	PCB assembly, system testing	Printing, cutting, and bookbinding machines
Product Customisation/ Product-range issue	Customised products increasing in plant designed for standard production	'Standard' product-range increasingly heavily customised; very low volumes	Many product-lines in one plant; rapid proliferation of variants of new product	Many low-volume products; poor manufacturing - marketing coordination*

*Note: During the research, Marketing functions were re-located from London to the plant

This research was carried out in a problem-centred fashion. As indicated in Table 8.1, each firm had a more or less clearly-recognised difficulty relating to the research focus and, as *quid pro quo* for allowing access, were to be provided with some feedback as to how they might address their individual problems. The problem area in each firm was taken as the starting-point from which the research could be prosecuted.

8.3 Corporate Strategy

If the hierarchical view of strategy used in Section 2.2 is adopted, the highest level is corporate strategy and is particularly concerned with the scope of the business. Here, the documentary sources are examined to identify the professed scope of the businesses and, in particular, the dimensions adopted for their definition. These are summarised in Table 8.2, using Abell (1980) as a starting-point and adding other dimensions as appropriate.

Note that the scope has been identified in a number of cases from strategies for the SBU (Strategic Business Unit). Philips and Honeywell are such large organisations with such diverse interests that, as well as trying to capture the corporate strategy for the whole firm, an attempt is made to find an intermediate level at which to identify the scope of the more immediate business entity.

Table 8.2 The Scope of the Businesses

Firm	Elements of Scope	Dimensions Adopted
Hyster-Yale	Lift truck and Warehouse Equipment; Aftermarket; various Sales territories	Customer Functions; Usage lifecycle; Geography
Honeywell (Control Components)	Electromechanical and solid state sensors in Europe	Product technologies; customer function; Geography
Philips BCS	Communications appliances and services for the office and small business environment	Customer functions, customer groups
Letts	International markets for diaries, books and related products; small book print/binding	Geography; Products; Process technology

8.4 Business Strategy and Competitive Position

The various strategy documents give some indication as to the explicit competitive stance of the business units. One possible summary of these is presented in Table 8.3. Table 8.4 is a summary of the as strategy articulated by various staff and inferred from such sources as marketing communications.

Table 8.3 The Explicit Competitive Strategies of the Businesses

Firm	Elements of Competitive Strategy
Hyster-Yale	Best supplier Quality at lowest cost Modern, competitive Product Range Lowest cost of ownership
Honeywell (Control Components)	Leading supplier
Philips BCS	Easy to install and use, reliable, adaptable 'Good value for money'
Letts	High emphasis on brand

Table 8.4 The Apparent Competitive Positioning of the Firms

Firm	Positioning	Evidence
Hyster-Yale	Quality product, technological reputation, after-sales service.	Marketing communications, sales, manufacturing and engineering interviewees.
Honeywell	(For EN products) 'affordable quality', technology and customisation. Exposure to price competition in deregulated markets. Apparent tolerance of poor delivery.	Marketing communications, marketing personnel, engineering.
Philips BCS	Confused. System design possibly strongest contender, but has oscillated between technological and price emphasis.	Interviews with marketing, manufacturing, development, logistics staff, marketing communications.
Letts	Varies. Does not aim to be cheapest, but still competes in spot-market bids. Branding important in retail markets.	Interviews with sales and product management, marketing communications.

The explicit strategies of Table 8.3 simplify what is in the actors' perceptions (Table 8.4) a contentious and poorly agreed issue. Hyster probably exhibit the most consistency between explicit and apparent positionings, and Philips the least. However, the only reason Honeywell and Letts cannot be subjected to more severe criticism is that their explicit statements are so vague in the first place.

Understanding the competitive position helps to determine manufacturing priorities, based on a classical manufacturing strategy concept (Skinner, 1969; Leong et al, 1989). So, having identified aspects of the firms' competitive positioning, their manufacturing strategies will now be examined.

8.5 Manufacturing Strategy

8.5.1 Content of Documented, Explicit Strategies

Three of the four firms have detailed, written strategy documents relating, in whole or in part, to manufacturing strategy. These are summarised in Table 8.5, which indicates by '?' the aspects not covered in the documents. Philips BCS are the only firm having a document actually *called* a manufacturing strategy. In other cases, the strategic documents arguably most likely to affect manufacturing are examined along the same lines.

Table 8.5 Formal Strategies Relating to Manufacturing

Aspect	Hyster-Yale	Honeywell	Philips BCS	Letts
Coverage	Worldwide. Concentrates on manufacturing plants	European. All microswitch products	The Plant. All products	Mission statement is only document
Source	Hyster-Yale HQ in USA	Microswitch Center of Excellence	Manufacturing Manager plus Procurement Manager	Senior Management
Process	?	?	Written by Manufacturing Manager	?
Main Issues	Basis for product allocation to plants	Market/technology strategy by product-line; manufacturing improvements for whole plant	Necessary manufacturing response to Market Plan	Defines the business, including 'to have world-class manufacturing capability' and emphasis on Brand
Use	?	Supposed to inform resource allocation to product/ technology development	Little. Abandoned as soon as written	?
Date/review procedure	?	1992. Appears to be a one-off	1989. Not revised since, no routine review	1992
Product Range	Attempt to allocate products such that part variety is minimised	Structured around product lines. No statements on product-range policy	Concentrates on implication of phasing in of new product-line. No explicit range policy	Mentions need to develop counter-seasonal products i.e non-diary
Customisation	Not mentioned	Little mention. One reference to forward-integration of one model	Not mentioned	Not mentioned
Prescription/ 'Plan'	Defines formal procedure for revision	?	Sets performance measures/targets	No
Connections to other strategies	?	Not mentioned	Derived from 1989 'Market Plan'	Not applicable

8.5.1.1 Competitive Criteria

The Philips BCS strategy is the only one that explicitly refers to competitive criteria such as delivery speed, cost and flexibility (e.g. Leong, Snyder and Ward, 1989). The other documents allude to some of the criteria. Hyster-Yale's describes a number of metrics by which part-count and product variety should be controlled, advocates 'product focus' and emphasises facility utilisation and order cycle time. Subsequently it includes market focus, facility utilisation and lowest product cost as the bases for assessing the allocation of products to plants. Honeywell's strategy document sets out different competitive strategies for each of its product lines, but reduces the manufacturing strategy (seen as a 'cost to serve' the market) to the same 'World Class' improvement programmes. They do include service and added-value as distinctive issues. Letts' Mission Statement exhibits an obsession with defining the scope of the business; the only reference to anything resembling a competitive priority is that it should be 'efficient' at its 'particular manufacturing expertise'. There is also a rather meaningless exhortation to be a 'World-Class manufacturer'.

Table 8.6 Manufacturing Strategy Decision Areas in Strategy Documents

Decision Area	Hyster	Honeywell	Philips	Letts
Facilities	✓			
Capacity				
Process Technology	✓		✓	✓
Vertical integration		✓	✓	✓
Production Planning and Control			✓	
Quality	✓	✓	✓	
Organisation	✓		✓	
Workforce	✓	✓	✓	✓
New Product Development		✓	✓	
Vendor relations		✓	✓	
Scope/new products	✓	✓	✓	✓

8.5.1.2 Decision Areas

The decision areas mentioned in the strategic documents are summarised in Table 8.6, which is a combination of the decision areas of Hayes et al (1988) and of Fine and Hax (1985). Beginning again with the only 'real' manufacturing strategy, it is perhaps unsurprising that it is the Philips BCS document that covers the most decision areas, explicitly or by implication. Hyster-Yale's is principally concerned with allocating product-lines to facilities and, as such, could be considered to address the facilities issue, even though it doesn't deal with the rationale for deciding how many facilities should be built, what capacity they should have, and where they should be - more typical elements of a facilities strategy. Honeywell's strategy concentrates on two

issues: the TQM, Supply-chain and World Class Manufacturing techniques it sees as underpinning manufacturing improvement, and the connection between products and product technologies. Finally, Letts' Mission Statement has little of substance in the decision areas - even those indicated in Table 8.6 are only very vaguely touched upon.

What is evident from Table 8.6 is that all the documents are concerned with scope and/or new products, consistent with Fine and Hax (1985). Hyster's is concerned with allocation of products or product-lines to facilities. Honeywell's is precisely *about* product strategies and the linkage of these to technology strategy. It draws on the BCG Product Portfolio (Henderson, 1979) allocating broad strategic approaches to the products such as 'invest to hold and maintain' and, in the link between product and technology, akin to Capon and Glazer (1987) in making explicit the connection between products and their underlying technologies. The Philips BCS strategy was written as a one-off response to a major review of marketing strategy, which was itself expressed in particular in terms of the changes envisaged in the product-range. In this sense it is also closest to the manufacturing strategy content models - it takes the marketing-defined products 'out there' (outside manufacturing) and designs - relatively thoroughly - a manufacturing system to produce them, expressed in terms of the decision areas. Just about the only thing the Letts' document does express with any precision is the scope in terms of the type of product that they consider themselves to be good at making.

The evidence here then, is that none of the firms explicitly define themselves a

manufacturing task in the sense that Skinner (1969) advocated, nor do they systematically work out the implications for each of the manufacturing strategy decision areas. The firms, perhaps with Philips BCS an exception, develop strategies for and around *products*. The abstraction of competitive criteria and decision areas does not seem to have such appeal. Even in the context of written statements of what Mintzberg and Waters (1985) would term *intended* strategies then, an important finding here is that the strategies relating to manufacturing are couched in the terms of concrete issues of products, plants and technologies rather than the abstractions of manufacturing strategy theory. It is also apparent that, in two or three of the firms, intended strategies for manufacturing improvement are also very readily conceived of as 'more concrete' packages such as TQM or WCM or MRP Class A than, for example, 'improve delivery reliability'.

8.5.2 Manufacturing Strategy Content Implicit in Current Activities

Having reviewed the explicit, written manufacturing strategies of the firms, the decision area framework of Hayes and Wheelwright (1984) will be adopted as a means of drawing together the supposedly strategically-significant aspects of each firms' operations at the time of the research. Tables 8.7-8.10 offer summaries of these issues and, where relevant, these will be expanded on in the discussion below. These Tables attempt to capture the present reality of the manufacturing activities of the firms, whether strategy documents identify the issues or not e.g. although Letts do not mention Production Planning and Control in their strategy document, the adoption of OPT has arguably been extremely influential in classic manufacturing strategy volume/variety terms. This is in keeping with Hayes and Wheelwright's espousal of the 'pattern in a stream of actions' definition of strategy (Hayes and Wheelwright, 1984: 30). For the time being, the longitudinal implications of this conception of strategy will be played down, and the emphasis will be on how manufacturing was at the time of the research.

Table 8.7 Apparent Manufacturing Strategy: Hyster-Yale

Decision Area	Apparent Strategy
Capacity	Chase - Main works recent redundancies; SPED workshop overtime plus 'flexing' labour between the two
Facilities	Three plants in Europe, specialised by product line (size-related) within overall product family
Technology	Main plant uses automated but not fully integrated processes up to assembly. Assembly uses mechanical handling but mostly fitter skills. Ten year old refit of plant.
Vertical Integration	Highly integrated. Main structures made from raw bar/sheet stock; engines, wheels, bearings, electrics etc bought in. Distribution through sole dealers (not owned by HY).
Workforce	Highly skilled in some areas e.g. CNC machinists regularly 'poached' by other firms, fitters are often from motor-industry background. Security lessened by current redundancy programme in recessionary period.
Quality	Quality inspectors report to manufacturing engineering manager
Production Planning & Control	Based on MRP for assembly and fabrication; JIT/kanban for machining of common components.
Organisation	Functional; mixture of UK- and Europe-level responsibilities; plant has supervisor responsible for each stage in process i.e functional basis. Standard costing.
NPD	Major NPD projects carried out at corporate level i.e. in USA; New series imminent
Vendors	Mostly centralised European purchasing
Scope	Addition of Yale products has added to scope. Customised products emerging

Table 8.8 Apparent Manufacturing Strategy: Honeywell

Decision Area	Apparent Strategy
Capacity	Not clear
Facilities	Complex European organisation. Newhouse only source in Europe for AOM EN, although sourcing from US is an option for Sales force.
Technology	Mostly small machines for AOM: bench fitting skills and cellular layout characterise process.
Vertical Integration	Newhouse essentially an assembly process for AOM products. Parts for other products manufactured in-house; AOM parts sourced both in UK and from US sister/mother plant; Newhouse has recently reduced backward integration by subcontracting machining, casting etc. Products 'sold' to Honeywell-owned but separate sales 'affiliates' who can buy from other plants e.g. US if product is available.
Workforce	Moderately skilled assembly employees. Again recent experience of major redundancy programmes has undermined security.
Quality	Quality Manager separate from Operations
Production Planning & Control	Assembly by kitting in small batches of say 10
Organisation	Complex mixture of functional and matrix, plant- and SBU-level responsibilities. AOM has production manager with sole responsibility. Standard costing.
NPD	Product- technology-centred; claim use of cross-functional teams for major NPD projects
Vendors	Recent backward dis-integration has emphasised 'World Class Purchasing' initiative.
Scope	Three main product lines within one plant; plant organised on product-focus lines but implementation had faltered

Table 8.9 Apparent Manufacturing Strategy: Philips BCS

Decision Area	Apparent Strategy
Capacity	Chase - plant were negotiating for extra shift at time of research
Facilities	One of three BCS plants. Others produce larger systems. Only world source for its products.
Technology	Capital intensive board assembly and test; labour intensive unit assembly. Board assembly in large capacity increments; mixed function/product layout. New investment.
Vertical Integration	PCB assembly in-house; increasingly, other parts bought in at highest level possible to leave assembly and test as principal functions of the plant. Core electronic components eg ASICs bought at SBU level. Recently reduced forward integration - sales through independent dealers who offer competitor products.
Workforce	Largely low-medium skilled assembly staff, mostly women. Male technician/supervisor group key
Quality	Quality Manager separate from Manufacturing. pre-production approvals and In-line testing play major role - use quality engineers.
Production Planning & Control	MRP - major MRP class A programme underway
Organisation	Relatively well-contained functional structure, recently consolidated on one site. Process-based production management structure shifting to product-based. Matrix structure for development projects. Standard costing.
NPD	Development has 'strategic mandate'; project management have considerable power. Formalised NPD Process.
Vendors	Increasing backward dis-integration; now 'strategic' purchasing as separate activity
Scope	Several products have been consolidated into one plant

Table 8.10 Apparent Manufacturing Strategy: Letts

Decision Area	Apparent Strategy
Capacity	Chase but trying to level by demand management
Facilities	Single plant for all products.
Technology	Process layout of relatively old machines. Little integration between stages. Front end in particular has ageing machines.
Vertical Integration	Backward integrated. Print from scratch, all design in-house, all parts bought as raw materials. Sales via Letts-employed representatives in most cases.
Workforce	Varies. Printers are skilled tradespeople; many other jobs machine-minders or hand-assembly/materials handling tasks.
Quality	Quality Supervisor reports to manufacturing management - sampling and inspection approaches; first in industry to be BS 5750 registered
Production Planning & Control	Seasonality key: production time in annual schedule booked; batch processes; OPT central.
Organisation	Functional management throughout. Product Management play key role in linking sales to production, particularly prior to consolidation of activities on one site. Sales forces for retail and commercial separate. Throughput accounting being adopted.
NPD	Annual product change. Few new products apart from this; no apparent NPD policy or process
Vendors	Use industry standard materials
Scope	Both Retail and Special Edition diaries

8.5.3 Consistency, Focus and Level of Aggregation

Despite many theoretical attempts to relate the decision areas to one another (e.g. Hayes and Wheelwright, 1984; Hill, 1985) the analysis of consistency remains case-specific. Hayes and Wheelwright do not specify categorically that certain capacity strategies must go with certain technology strategies. They do, however, note that

explicit or implicit decisions must be made in these areas, that they are interrelated, that certain (say) capacity strategies *tend* to have certain implications and it is the pattern of decisions that matters. Hill's profile analysis, based on the process choice and the trade-off (Hill, 1985: 92-93) provides a tool for diagnosing broad inconsistencies but again stops short of prescription. Again, we are in the hiatus between analysis and strategy formulation that Mintzberg (1994: 321) notes. The difficulties of identifying the firms' competitive strategies in the first place notwithstanding, there are no gross inconsistencies at this level of analysis in terms of manufacturing strategy theorists such as Hayes and Wheelwright (1984) and Hill (1993).

For the time being, it is assumed that the firms are at Hayes and Wheelwright's Stage 3 where the emphasis is on providing 'credible support to the business strategy' (Hayes and Wheelwright, 1984: 396; Mills et al, 1995). Although it is difficult to clearly identify the competitive priorities of each firm, this section begins by assessing the consistency between the apparent manufacturing strategy and the apparent competitive positioning.

The implication of much of Hyster's manufacturing operation is an emphasis on low unit cost production of a high volume of products within a carefully-defined range of specifications. It has a relatively highly-automated and vertically integrated process, supported by MRP and a functional structure, controlled by day rates on the line and standard costing systems. This is highly appropriate for the manufacture of a range of relatively complex products in high volumes to a steady demand pattern.

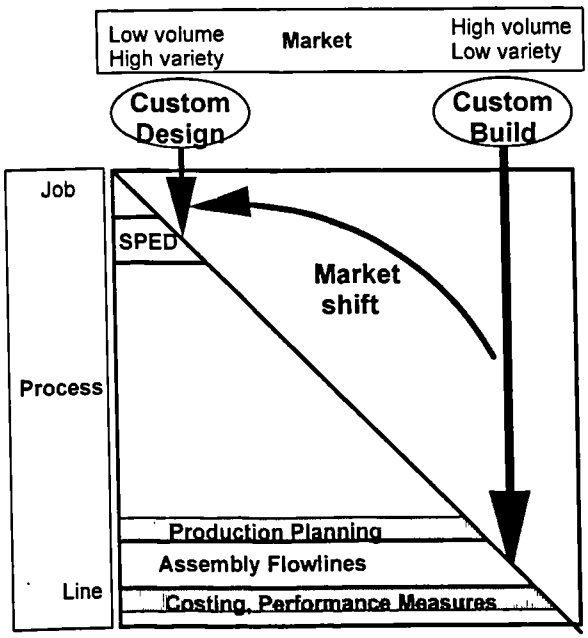
Honeywell's processes for AOM and many other products are less vertically integrated and less capital intensive and adopt a cellular layout. In these ways it is appropriate for low-volume high variety and less consistent demand. Philips BCS have a product-based, vertically dis-integrated but, in parts at least, capital intensive process. This is again suitable for high-volume manufacturing of a number of different products, in relatively consistent volumes. Letts have perhaps the most questionable macro strategy insofar as they are highly vertically integrated in respect of their printing processes, where they have old machines and some difficulties in staffing due to the long lead-time for training printers.

Although there is apparently reasonable consistency between competitive positioning and manufacturing strategy at plant level, there are clearly serious problems. All of these problems can, to a greater or lesser extent, be characterised as a loss of focus. In part, this takes the form of the classic focus problem of too wide a range of volume/variety profiles within the same plant (Skinner, 1974). The analysis proceeds on the basis that, in the short term at least, there *are* trade-offs embodied in the structural and infrastructural aspects of the plants i.e. the conclusions of Skinner (1992) and New (1992) are favoured over the views of Schonberger (1986) and it will be taken that production systems are suited to particular manufacturing tasks, here reduced to the volume/variety dimensions.

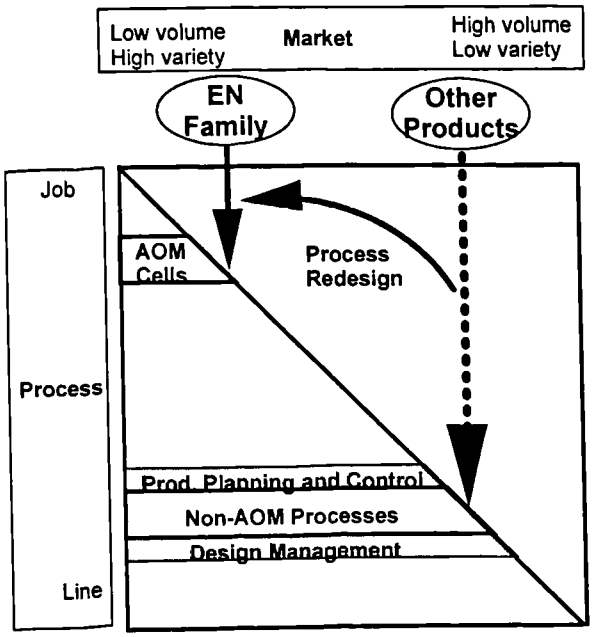
Whilst some elements of the manufacturing system are differentiated accordingly, (e.g. Honeywell's selective use of low-capital cells) others are not (e.g. Honeywell's centralised, common production planning and control). These issues are summarised

graphically in the adapted product-process matrices (Hayes and Wheelwright, 1979a) in Figure 8.1 a-d, which indicate separately the main structural and infrastructural elements of the firms' manufacturing operations. In each of these, the manufacturing process choice is indicated by a horizontal white band, and the supporting infrastructure by a horizontal grey band. On the trade-off view, the system is appropriate when both bands strike the diagonal at the same point as the market demand, in volume/variety terms.

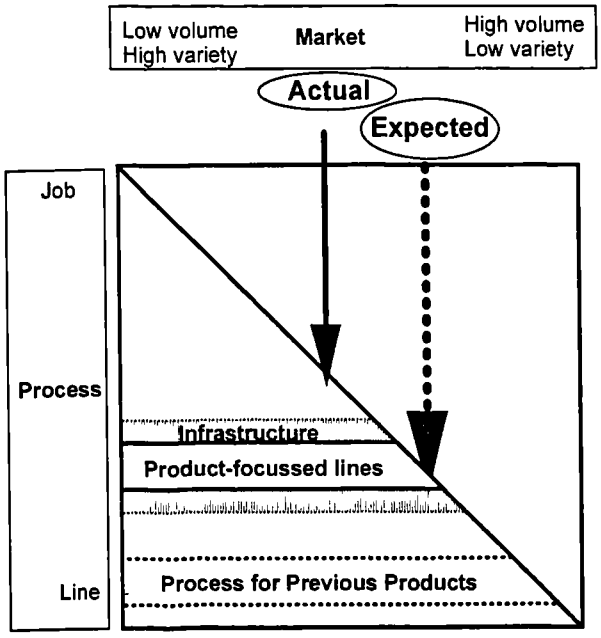
Hyster-Yale's Irvine plant is designed for the production of custom-built trucks. The assembly stage can be carried out on a flowline basis because, although there are many different permutations, the fitting activities are well-established and very similar regardless of the precise specification. The infrastructural aspects - especially the MRP and costing and performance measurement - is consistent with this. The process implications of custom-designed trucks had been accommodated to some extent by the provision of a separate SPED Workshop with a separate Superintendent. However, other aspects of the infrastructure were not differentiated: the standard costing system only captured additional material costs and the forecast extra labour costs, and took no account of potentially different rationale for customising heavily-customised products. The materials planning system simply couldn't accommodate SPED work, so manual intervention and various forms of circumvention were necessary. Whilst this might be an acceptable compromise if SPED were only a small proportion of the volume, in the event it is 30-40% of volume and, as such, more than a minor aberration.



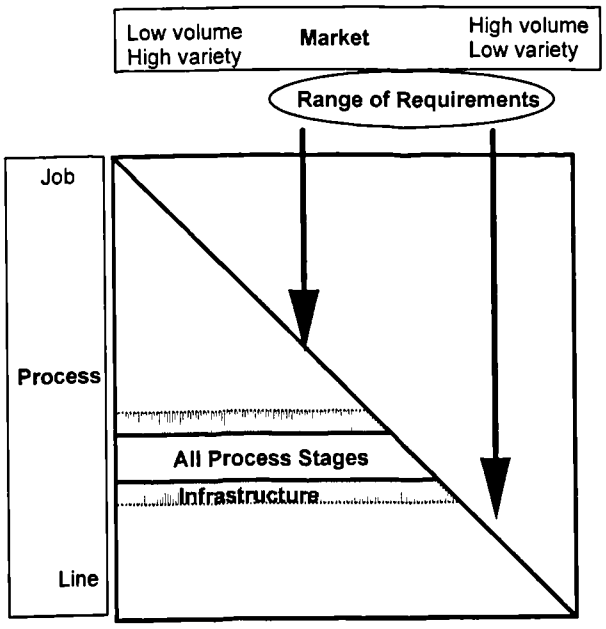
(a) Hyster-Yale



(b) Honeywell



(c) Philips BCS



(d) Letts

Figure 8.1 Consistency of Structural and Infrastructural Decisions with Markets

Figure 8.1b shows that Honeywell's EN products are all required in low volumes and that the (cellular) manufacturing process is appropriate to this. There is, though, a product-based inconsistency at plant level in that, although the production process is appropriate to AOM products, some aspects of the infrastructure are not. Production planning and control is common for all products in the plant and, as shown in the case, lead to a lack of visibility and control of parts and of delivery performance. The most important problems arise at the design-manufacturing interface. Some AOM products, including some EN switches, have extremely long leadtimes between design and first production run, very long intervals between runs, and a great deal of design work content due to customisation and forward integration. However, the same approaches are adopted in respect of design staffing and procurement as for other microswitch products e.g. industrial. Notably, this has involved the redundancy of the few engineers whose involvement in most AOM projects played a very important part in providing some technical continuity from design to manufacture and from one production run to the next, in the absence of any other more systematic means of achieving it. The panel chronology in particular (see 5.6.3) exposed the complete lack of familiarity of the designers, planners and shop-floor alike with tall BOMs, leading to recurring and costly quality errors. So, whilst the change in the production process to cellular layout is appropriate to EN products, the infrastructural aspects have been, so to speak, left behind.

Philips BCS have, at one level, an extremely complex focus problem. Their consolidation of production into one workshop leaves them with products at various stages of their life-cycle in one plant. In that they have re-organised from a functional

layout to a product-based layout, with a production management structure along the same lines, they have acted to mitigate the effects of this complexity. (This has already represented a big change from their previous business of making high-volume basic telephones.) But their misjudgment of the market for the newest product, Sopho-S, has made matters considerably worse, as is emphasised in Figure 8.1c. Although the causes and implications are many and complex (see case), in volume and variety terms they can be summed up as the difference between the 'expected' market and the 'actual' shown in Figure 8.1(c). This slightly closer look at the design of BCS operations reveals that neither process nor infrastructure are appropriate.

The process and infrastructure of Letts is designed for large batch production. The mix flexibility (Gerwin, 1993) varies between process stages but, in summary, the position on Figure 8.1d captures most aspects. As described, and as the recent introduction of TPA-based costing has sought to address, the range of volumes has been very large, with small batches causing particular difficulties at printing (due to long changeovers) and large batches potentially causing over-loading of the capacity in some of the 'semi-off-line' bindery operations.

In all the cases then, the volume/variety dimensions help in diagnosing the problems but they do not explain everything. If all the products in each plant suddenly came to be required in precisely the same volumes, difficulties would remain. Hyster would still have uncertainty as to labour content, cost, and technological requirements of custom-designed products; Honeywell would still have the unusual complexity of builds, unfamiliarity of products only required very intermittently ('strangers') and

difficulty in relating the custom design cycle activities to the material cycle activities; Philips BCS would still have two parallel specifications due to its original under-engineering of the new product-line; and Letts would still have a seasonality-induced concentration of custom-designed products to produce at the end of the year. These are but a few of the problems that are not due purely to the volume/variety issue. But they *are* all related either to 'genuine' customisation or (in the case of Philips BCS) to the unusually high technical requirements of a small segment of its market, which amounts to the same thing in many respects. This confirms, with more empirical evidence than in any of their own work, the assertions of Shapiro (1979, 1987) and Blois (1980a) as to the importance of customisation and its relationship to manufacturing strategy.

In at least two of the cases, the level of aggregation for structural decisions is different to that for infrastructural ones. The differentiated process designs of Hyster and Honeywell were undermined by their having, in many respects, the same infrastructural designs as the rest of their respective plants. This general point is shown in Figure 8.2(a).

On the larger scale, other inconsistencies are evident. Hyster-Yale tried to apply the same standardised flow-line approach to all their plants following the success of Craigavon, even though the products differed. They also use the part-variety count as a key metric *for all plants*, even though some have become low-volume, high-variety plants (Craigavon) and others high-volume, low variety (Nijmegen) (Figure 8.2(b)). Honeywell define different strategic tasks for each of their product groups,

but articulate identical emphases in manufacturing for all of them (Figure 8.2(c). Philips BCS market the Sopho-S products made at their UK and Dutch plants as large-end and small-end versions of the same product. But each part of the range was designed locally and, as a result, have basic differences in the details of, for example, user interface characteristics, which makes 'trading up' across from one plant's products to the other's problematic for the customer. They also do not standardise componentry e.g. resistors used are, arbitrarily, to different tolerances in each plant, so transferring production between plants was difficult. Product strategy is at a higher level of aggregation than manufacturing strategy.

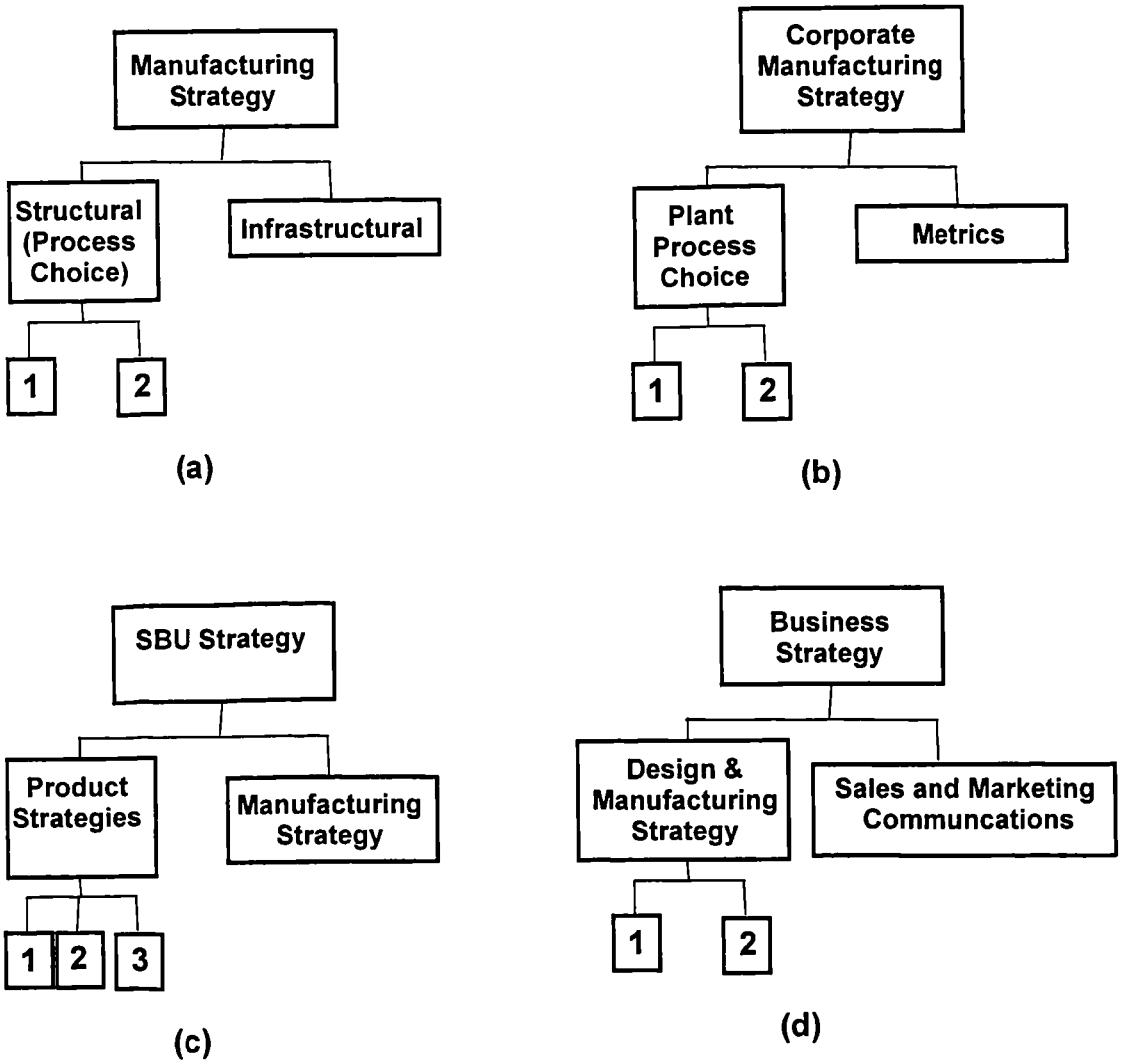


Figure 8.2 Manufacturing Strategy Resolution

These are additional to the in-plant inter-product-line focus issues and are evidently very important. Problems appear to arise where there is inconsistency *in the level of aggregation* used. This has not been identified elsewhere in the manufacturing strategy literature and the term **manufacturing strategy resolution** is proposed. This concept can be used to assess deliberate and emergent strategies across hierarchies and between functions.

8.5.4 Comment on Customisation in the Manufacturing Strategies

There is no mention of customisation nor any explicit policy on product-range in any of these documents. Hyster seems to acknowledge that there are manufacturing reasons for allocating a product to one plant in favour of another i.e. a concern with consistency of manufacturing task in terms of common parts. Hyster's Irvine plant customises some 40% of its products; Nijmegen customises more, Craigavon much less, and yet customisation is not mentioned as playing any role in the product-allocation process. Honeywell's document is careful to set out different strategies for each major product group (except, as we have seen, in respect of its manufacturing initiatives) but does not consider the effect of the complete product-range at plant level, or the effect of inter-plant sourcing, or the role of customisation, either in general or in relation to specific product-lines. The only exception is a passing reference to forward integration for EN switches, which amounts to customisation. BCS refers to the need for 'flexibility' due to increased product variety and, in so doing, is the only document to explicitly acknowledge that the product-range, as well

as the individual products or product-lines, is important. However, it is not clear which form of flexibility (e.g. Slack, 1983) is required. It also emphasises the variety that was envisaged due to internationalisation of products, but not that due to the production of different product lines of different ages in the same plant. In that it was written just before the operations were consolidated into one plant, to a certain extent it was a strategy written for a combination of products and facilities that never existed.

In conclusion, it is apparent that the competitive and manufacturing strategies are not well-developed in the terms of the relevant literature but *even if they were*, they would not take account of the customisation effects.

8.5.5 Summary on Manufacturing Strategy

In summary:

- the explicit manufacturing strategies are often poorly articulated compared to the prescription of the literature;

- the implicit manufacturing strategies are broadly consistent with the type of product/market environment the firms operate in;

- the implicit i.e. actual manufacturing strategies are undermined by an inability

to cope with inter-product differences that have cumulatively strategic implications, and by inconsistencies between process and infrastructure;

- different levels of aggregation ('strategy resolution') in strategy formation have resulted in major problems;

- customisation eludes both the manufacturing strategy literature and the practices of the firms.

8.6 A General Model of Product Customisation

The preceding sections have analysed the manufacturing strategies of the firms using mostly well-established manufacturing strategy theory. The rest of this chapter departs from this and develops a novel model of the product customisation process and the strategic implications that flow from it.

The elements of the model are developed systematically in the following sections, but a simple form of the model is introduced here to provide a framework for understanding the detailed explanation to follow. This is shown in Figure 8.3. The model represents the process in two main stages, problem-solving and transfer (Håkansson, 1982), which are linked by the product specification. The connections of these with customer expectations, products architecture, flexibility, the trade-off and manufacturing strategy competitive criteria are indicated.

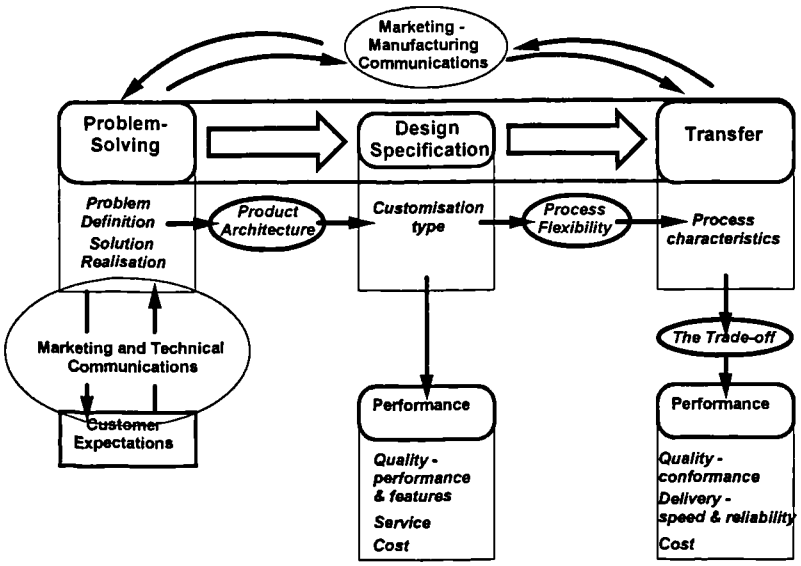


Figure 8.3 A General Model of Product Customisation

8.7 Aspects of Product Customisation

Customisation has serious strategic implications for manufacturing in the firms studied. The manufacturing strategy literature does not treat customisation adequately and even the literature (notably from industrial marketing) that *does* discuss customisation does not reflect, in the typologies and characterisations of customisation proposed, all of the aspects of customisation that evidently have a bearing on the manufacturing process and activities related to it. This section then, brings together a number of these aspects of customisation. Customisation is examined first from a demand-side perspective, then from the supply-side. Following that, patterns linking the two together are identified, and the role of the service element is discussed.

8.7.1 Demand-Side Issues

Customised products of one sort or another are required because the customer's requirements cannot be satisfied by 'catalogue' products. 'The catalogue' defines what the basic offerings are, although sometimes a product cannot be defined fully by reference to a catalogue. For example, whereas a Philips BCS customer could simply order a particular model of switching system and the product would be fully and unambiguously defined, a Hyster customer could only specify the *platform* required before intervention would be needed, usually in the shape of a dealer, to specify the options required. Only when both are specified can the order be placed. In theory, every possible permutation could be included in the catalogue but (a) due to the large

number of permutations and (b) because of the need for only feasible and safe combinations to be chosen, the intervention of the dealer, assisted by the Sales Ordering computer system, is necessary.

It is, of course, simplistic to say that customers' needs 'cannot' be satisfied. In the case of Hyster, for example, customers will turn to custom-designed products when catalogue platforms with the most relevant options do not adequately provide the real or perceived benefits required. But with Hyster products and with many others, there will usually be compromises to be made, notably between the potential extra cost and trouble involved in a custom-designed solution and the extra benefit to be derived from it. It may be the case that a standard or custom-built product will provide most of the benefits required and the customer will accept this as the best compromise. This is not an objective process nor, as established by the IMP literature (e.g. Ford, 1980, 1984; Håkansson, Johanson and Wootz, 1976) is it an isolated and instantaneous decision. The expectations of the customer change, influence and can be influenced by the interaction with the supplier. This process can be represented in a relatively simple fashion as in Figure 8.4.

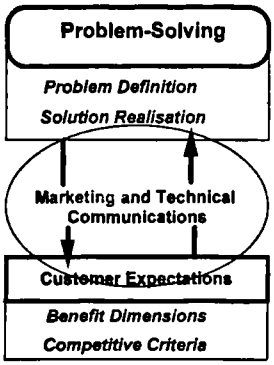


Figure 8.4 Customer Expectations and the Problem-Solving Cycle

From the supplier perspective this is labelled the problem-solving process (Håkansson, 1982) and the arrows indicate its iterative and interactive nature. The diagram also indicates the customer as having certain expectations, which are understood to change as the process proceeds through what may be many social, communication and even product (e.g. prototype) episodes (IMP Group, 1982). (For the sake of simplicity, other aspects of the interaction model such as atmosphere are left out of this representation.) The diagram also includes a distinction between problem-definition and solution-realisation, which is explained in the following subsection.

8.7.1.1 Problem-Definition and Solution-Realisation

In some problem-solving cycles, there is an emphasis on problem-definition, in others, on solution-realisation. For example, the simple request for a particular key switch on a Hyster FLT requires no problem-definition effort but, as it transpired, required a considerable amount of solution-realisation; more predictably, other trivial and straightforward requirements such as a flashing light may require considerable design effort to ensure safety and compatibility. On the other hand, considerable problem-definition work may be required - for example to calculate or otherwise establish loading and environmental conditions for a Honeywell EN switch - but the solution realisation may be trivial; indeed, it may transpire that a standard product will suffice. This suggests a categorisation of problem-solving situations, as in Figure 8.5, and a need for interaction between various individuals under various circumstances.

Solution Realisation \ Problem Definition	Low	High
Low	Little interaction	Applications Eng. Sales Engineer Customer
High	Design Eng Applications Eng	Design Engineer Applications Eng. Sales Engineer Customer

Figure 8.5 A Typology of Problem-Solving Situations

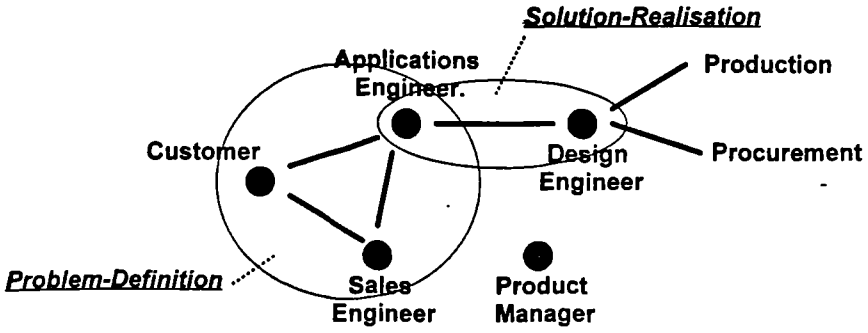


Figure 8.6 Typical Actors in the Problem-Solving Process

Problem-definition is typically the role of the salesperson and/or application engineer and/or the customer. Solution realisation is typically the role of the design engineer with the applications engineer. The role of the product manager varies considerably and may include aspects of none, one or both parts of the process. The two aspects of problem-solving have strong parallels with the service operations management categorisation of front-office and back-office:

Problem-definition	Front-office
Solution realisation	Back-office.

This will be discussed further (section 9.6).

It is clear from the cases that the nature of the problem-definition stage is very influential. At Honeywell, the typical pattern was late involvement in the OEM project and therefore little discretion in problem definition. On top of this, for various reasons, there may be some considerable delay between the *de facto* beginning of the project and the formal notification of the plant by the sales engineer i.e. submission of the SP form in the Honeywell case. The relationship that exists between the customer and the sales force before the project is crucial here, for example in determining when the sales engineer will first be aware of a forthcoming opportunity and when the customer will begin to divulge information that will enable the sales and applications engineering staff to become involved in problem-definition.

Although the emphasis here is on design solutions, the problem-solving stage also shapes the mutual understanding of the competitive criteria for the transfer stage (i.e. the usual manufacturing strategy criteria). At Honeywell, it may be stressed during problem-solving that delivery reliability in the transfer cycles is crucial so as to avoid delays to the OEM-customer's build programme. At Letts, the diary budget of the buyer may be as important in the problem-solving stage as the design criteria. The problem-solving stage is thus a crucial opportunity for the manufacturer to understand and possibly influence the customer's expectations for the transfer cycles. This can

be represented as in Figure 8.7.

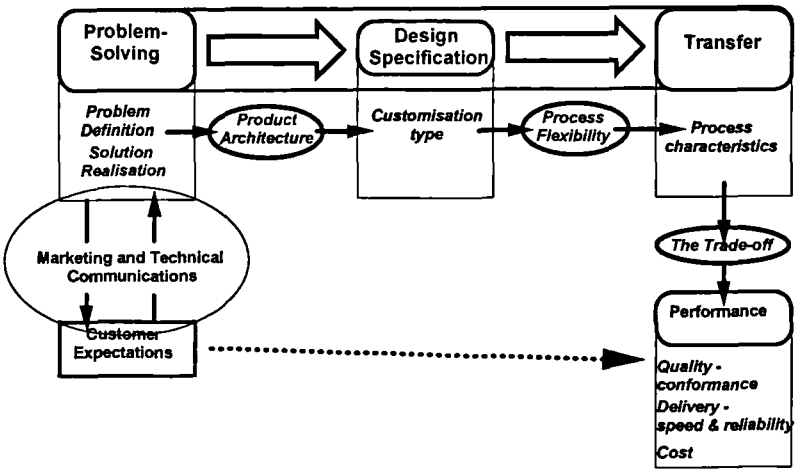


Figure 8.6 Problem-Solving Shapes Expectations of Transfer

8.7.1.2 What is Customisation?

Garvin (1987) identifies eight dimensions of quality. The general thesis of his article is that by identifying more exactly the various forms of quality, firms can design their operations to deliver those that their customers value and to 'compete on selected dimensions'. Two of these dimensions can now be seen to relate to customisation:

Performance: '..refers to a product's primary operating characteristics ....

performance rankings, however, are difficult to develop, especially when they involve benefits that not every consumer needs....The "superior performer" depends entirely on the task.' (Garvin, 1987)

Features: 'Features are the "bells and whistles" of products and services....To many customers..superior quality is less a reflection of the availability of particular features than of the total number of options available. Often, choice is quality: buyers may wish to customize or personalize their purchases.' (Garvin, 1987)

Garvin's distinction closely follows Shapiro's between universal benefits and diverse specifications. However, with the various examples from the cases to draw on, Garvin's discussion appears somewhat imprecise or confused. Philips BCS's Sopho-S product has many features that are common to all of the range; in this sense, the features do not all offer a way of 'customising ..their purchase'. Garvin also seems to hint at another aspect of customisation: that customers are attracted to particular manufacturers because of the *potential* choice they offer, even though in the event the customer may not require any or many of the features.

This indicates that the motivation for customisation of one form or another are very variable:

- choice for its own sake: it is the process of being involved in problem-solving *per se*, rather than the customised outcome, that matters;

- some importance is attached to having different features, most of which are required by all customers

- considerable need for features that are positively unattractive to other customers (e.g. hot weather modifications for a Hyster FLT);

- need for higher basic performance (universal benefit), possibly with features as well.

This quality-based way of conceptualising customisation from the supply-side is particularly useful in linking it with manufacturing strategy, because 'quality' is one of the competitive criteria. The extent to which this is achieved is determined at the point where the specification is fixed i.e. at the end of the problem-solving stage - see Figure 8.8.

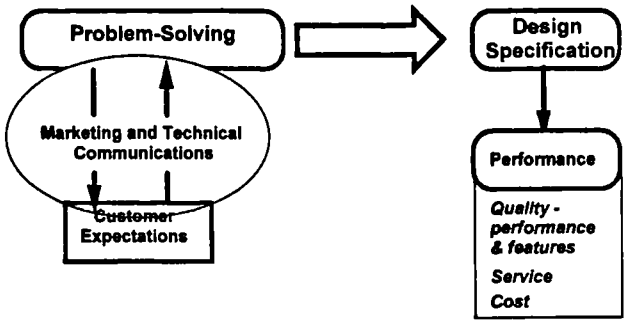


Figure 8.8 Performance Objectives at the Specification Stage

Also determined, although difficult to quantify, is performance on the competitive criterion of 'service', and the cost to the organisation of defining the specification and providing such service elements as may have been required. Section 8.7.4 returns to the service aspects.

Blois (1980a/b) has identified another aspect of customisation in his distinction between custom *marketing* and 'special-order' *products*. If we take 'marketing' to include marketing, sales and physical distribution, then, regardless of whether the product as defined by the specification is a customised product, the marketing *process* may be anything from mass marketing to individually customised. For example, although a Hyster truck may involve considerable custom-design work, the problem-solving and transfer processes may be perfectly standard - carried out through the dealer network and delivered and invoiced in exactly the same way as for a standard product. On the other hand, a customer may have a dedicated major account salesperson rather than the normal dealer contact, but order standard products. The marketing aspects of problem-solving and transfer processes respectively may, therefore, be customised independently of each other.

Based on the case examples, process customisation appears to map onto channel structure to a large extent. The following categorisation emerges:

Mass: Most customers dealt with via standard processes e.g. Hyster or Philips BCS Dealers

Segment: More than one customer dealt with, but restricted grouping e.g. Honeywell AOM salesperson, Letts Retail salesperson

Individual: Salesperson deals exclusively with one customer, often by-passing parts of conventional channel e.g. Hyster major account sales.

The demand-side aspects of customisation will be important in understanding the competitive advantage that customised products, services and marketing can provide. However, it is also necessary to understand the issues that are particularly relevant to manufacturing and related functions i.e. those who will supply customised products, and the next section considers supply-side aspects.

8.7.2 Supply-Side Aspects

The implications of customisation for manufacturing, procurement and engineering or design - the functions consistently involved in providing the customised products - are many and varied. However, three issues above all largely determine the nature of the manufacturing activity: the inclusion or otherwise of custom-designed elements, the nature of optional features, and, strongly influencing these two, product architecture.

8.7.2.1 Custom-Design, Custom-Build

The distinction between custom-build and custom-design is arguably the most important because the transition to custom-design gives rise to the need for design engineering and various materials management interventions. This distinction has been drawn in some of the typologies of customisation (e.g. Hutt and Speh, 1992; Sharma, 1987; Mintzberg, 1988) but the implications for manufacturing have not been examined. Furthermore, although Sharma makes the distinction between customer-specified options and 'modified to customer specification', he treats both of these under the umbrella of 'standard products'. The implication of Sharma's typology is that only a product designed entirely to customer specification with no pre-existing elements is 'non-standard'. Where an attempt *is* made to understand the manufacturing consequences, customisation is reduced to a simple continuous variable, of which there is 'more' or 'less' (e.g. Shapiro 1979). Only Easton and Rothschild (1987) allude to the implication of the discontinuity between custom-build and custom-design.

Table 8.11a shows the positioning in terms of customisation content of the firm's deliberate offering i.e. that included in sales literature and other marketing communications; Table 8.11b shows the positioning of the products the firms were actually making at the time of the research. In these tables, wherever text appears, the firm offers (in Table 8.11a) or actually produces (in Table 8.11b) products involving that type of customisation; the bold boxes show the broad emphases of the market. Note that the vertical axis is not a continuum from 'high' to 'low' customisation used by Shapiro (1987), but contains discontinuities represented by the horizontal lines, in

the manner that Easton and Rothschild (1987) discuss.

These Tables show that, in at least three of the four firms, the 'migration' of the business has involved crossing the division between custom-build and combined custom-build and custom-designed products. This has serious implications for marketing and manufacturing in both design and material cycles. Once that line is crossed, a new range of activities, interfaces and uncertainties are invoked. Applications engineering, design engineering, testing, prototyping and special-purpose procurement are some of the extra design cycle activities, all of which have to negotiate the interface with 'standard' activities. The Hyster case, amongst others, shows that most, if not all, products that might be classified as 'custom-designed' are in fact a combination of custom-build and custom-designed options and it is arguably the combination of the two that creates many of the difficulties encountered.

Table 8.11 a Customisation in the Firms' Deliberate Offerings

	Hyster-Yale	Honeywell	BCS	Letts
Custom-Design		Custom-design offered		
Combined Custom-Build/ Custom Design	Occasional			Custom diaries (all incorporate some standard 'modules')
Custom-Build	Products are combination of standard platform and options	Customer-specified details may be varied	All products standard, but specific to geographical area: territory specificity via modules	
Catalogue		Catalogue presents 'standard' products		Catalogue items for retail

Table 8.11b Customisation in The Firms' Emergent Offerings

	Hyster-Yale	Honeywell	BCS	Letts
Custom-Design		Some products almost entirely customised		
Combined Custom-Build/ Custom Design	Increasing proportion and level of customisation	All new product requests treated as customised; heavy forward integration	Arguably, little territory specificity via modules - different platforms and hardware.	Custom diaries (all incorporate some standard 'modules')
Custom-Build	Products are combination of standard platform and options			Increasing use of badged, essentially standard products
Catalogue		Catalogue 'standards' are merely examples of custom products		Catalogue items for retail

Within the elements that are custom-designed, there are further distinctions to be made. The two which emerge as important in the Hyster case in particular are (a) design work content, and (b) special manufacturing labour content as shown in Figure 8.8. Particularly where both of these are high, the need for design-manufacturing integration is great.

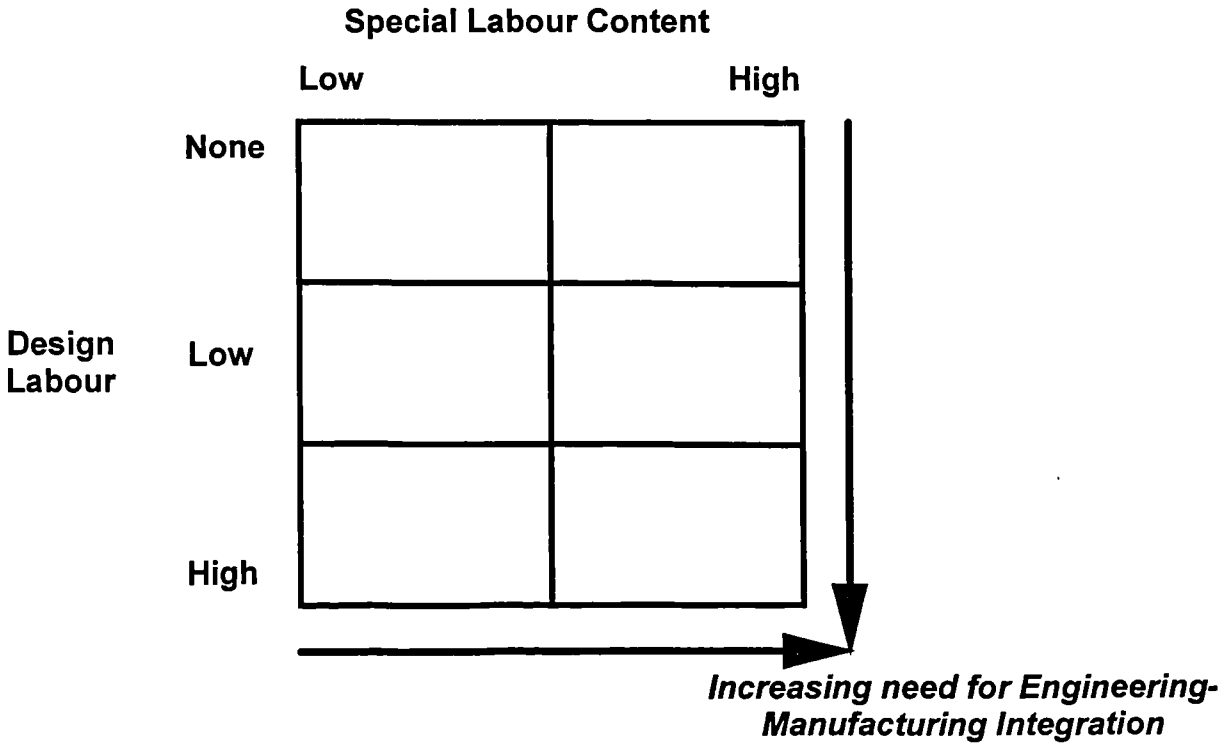


Figure 8.9 Custom-Designed Elements - Design and Manufacturing Work Content

8.7.2.2 Options: Essential Features and 'Optional Extras'

The Hyster and Honeywell cases in particular demonstrate that there are options that must be specified one way or another e.g. a FLT must have tyres of some sort, but the customer chooses which. There are other options which are truly 'optional

extras': a FLT may or may not require lights.

Furthermore (e.g. Kotha, 1995) there are some options which are specifiable simply in parametric terms e.g. the frame size of a bicycle, derived from the customer's inside-leg measurement or the mast-height of a FLT, derived from the precise dimensions of the customer's materials handling environment. The specification of such 'parametric' options may be continuous or discrete. The Hyster case illustrates the potential inflexibility of a FMS, because whereas the manufacturing system has complete mix flexibility so long as the options were specified at the discrete intervals it was designed to produce, it suddenly became very inflexible where the specifications fell in between the intervals.

The substitutional options are those which, whether optional extras or essential, are specified in either/or terms. For example, a Philips BCS switching system has either Italian or Spanish as its operating language, with no sense that one is bigger than the other - just different. (This is analogous to the 'parallel' product-ranges of Kent (1986).)

These custom-build option dimensions can be combined in a matrix such as in Figure 8.10. Any optional feature can be categorised into one of the boxes in the matrix. Analysis of options along these lines can inform the design of product architecture and the manufacturing system. The case examples have demonstrated the danger in having a manufacturing system that works in discrete parametric terms, when demand is or moves toward continuous parametric. Parametric options require entirely different

forms of capability than do substitutional: the former is largely a matter of the product flexibility of a single stage in the manufacturing process, the latter more to do with materials management and product structure. The boundary between essentials and optional extras is also an important one. The more that falls above the line, the more the labour content, planning variables and costs are likely to be consistent. However, customers may feel better served if they have what they perceive to be optional extras. This issue is very product/market specific.

	Parametric		
	Continuous	*Discrete*	*Substitutional*
Essential			
'Optional Extras'			

Figure 8.10 Custom-Build Options

8.7.2.3 Product Architecture

Both the preceding sub-sections demonstrate that the relationship between the product architecture (see 2.4.4.5) and the dimensions along which customers' special requirements vary is of fundamental importance in linking major New Product Developments with customisation. Whilst a detailed examination of product-range architecture for the firms is beyond the scope of this research, it is evident that the original product design casts a long shadow over subsequent problems involving custom-design. The recently-emerging literature on product-family management (e.g.

Sanderson and Uzumeri, 1995) and interface management (Sundgren, 1996) gives some pointers here, but it is notable that these concentrate on consumer durables whereas, in industrial markets, it is sometimes unavoidable that individual firms require genuinely unique solutions that cannot be chosen from 'options'. In the limiting case, features that derive precisely from the customer's uniqueness e.g. the livery of a lift-truck or the design of the cover of a company diary, will always require custom-design. Doubtless though, attention to the architecture of the original product can eliminate the need for some aspects of custom design.

The type of customisation specified at the end of the problem-solving stage is thus a function of the product architecture. This connection is shown in Figure 8.11.

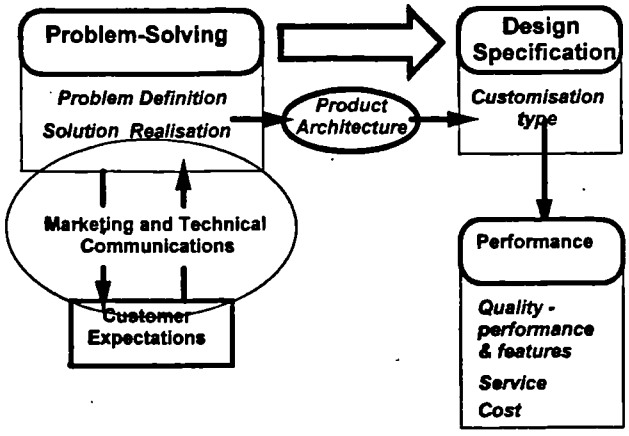


Figure 8.11 Product Architecture Links Problem-Solving to Specification

8.7.3 Patterns of Customisation

The discussion so far has concentrated on a single problem-solving process in fairly abstract terms. This section looks beyond that and takes account of (a) the relative timing of the problem-solving and transfer stages (b) the number of repetitions of transfer stages for each problem-solving stage and (c) the role of any single problem-solving and transfer pair in the broader relationship with a customer or group of customers.

8.7.3.1 Problem-Solving and Transfer: Timing and Repetition

The transfer process involves, at the very least, the physical transfer of the tangible product to the customer. This may be through the field unit involved in problem-solving, or through an alternative logistics operation, or both. In most of the cases, physical distribution was done by a third party logistics firm. The main exception was Hyster, where the dealers who were involved in the problem-solving stage also received, inspected and delivered the product. The problem-solving cycle may be closely followed by the transfer cycle or there may be a long delay between the two; there may be one transfer cycle or many. Figure 8.12 represents this for the four firms.

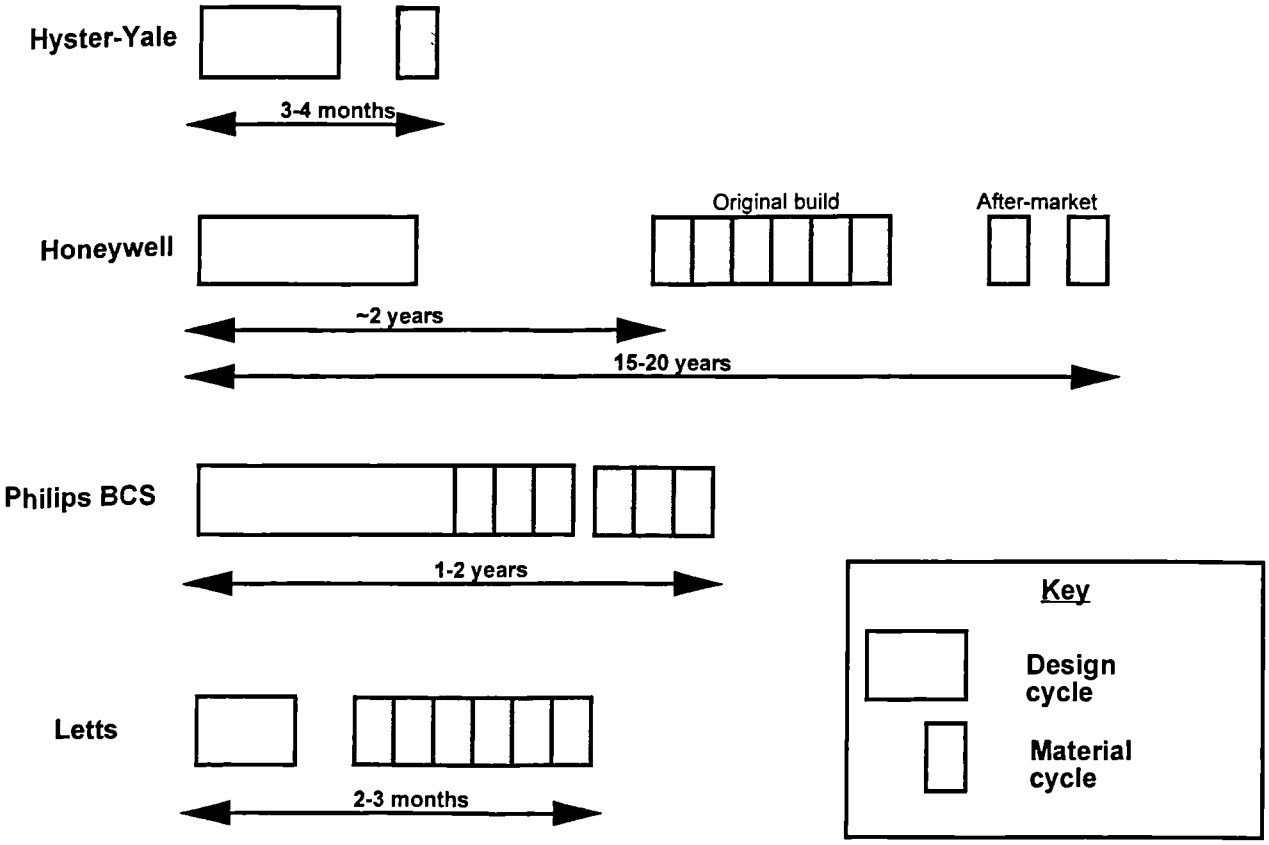


Figure 8.12 Problem-Solving Cycle and Transfer Cycle - Timing and Repetition

This pattern determines many of the scale economies and information system requirements for the whole manufacturing/engineering system - see Figure 8.13. Low repetition (e.g. Hyster) makes it necessary to go through many problem-solving cycles to achieve volume/revenue targets. This makes the automation of the problem-solving process attractive in cost terms. It also requires clear and standardised communication of specification to manufacturing i.e. the solution-realisation-to-transfer link. High repetition (e.g. Philips) makes design-for-manufacture, cost minimisation and reliable and optimised supply-chains more important. Decisions about the precise level of vertical integration are critical. If there are long gaps between problem-solving and transfer cycles (e.g. Honeywell), then mechanisms are required that promote continuity. This might place the emphasis on extremely explicit process specifications

and purchasing requirements for bought-in parts. Where volumes are low and batches infrequent (Honeywell again), the need for these aspects of 'collective organisational memory' are even more important. Finally, these patterns also influence the way in which performance is controlled against expectations. This includes the outcome of the problem-solving stage, i.e. how well the product eventually specified meets the customer's requirements, and of the various transfer stages i.e. delivery speed, reliability and conformance quality.

From the business perspective, the provision of appropriate cost accounting and control mechanisms are a vital part of this. For example, Honeywell did not have any acceptable way of relating actual achieved costs to original quotes which, in many cases, had been made years earlier. The centralised, standard production control and accounting systems were organised on a product-line or process basis; a more appropriate focus for AOM products would have been the customer account.

Repetition	Delay between Problem-Solving and Transfer: Low	Delay between Problem-Solving and Transfer: High
Low	Automate Problem-Solving by Information Systems	Continuity of personnel - integrated design engineering and production
High	Design for Manufacture Transfer-cycle cost reduction Supply-chain	Mechanisms for continuity - detailed process specs, 'collective organisational memory'

Figure 8.13 Timing and Repetition: Implications

8.7.3.2 Role of Customisation

Blois (1980a/b) notes that customised products may be produced outside the normal scope of the firm to satisfy a large or otherwise important customer and, as such, introduces the extra dimension of the relationship into the picture. This has, of course, been treated at length by the IMP literature (e.g. IMP Group, 1991). It is instructive here to examine the role of customisation in each case.

Honeywell undertake some of their customised products so as to retain all the business with a particular customer and allow competitors 'no visibility in the account'. It is an extremely concentrated market and the success of the business stands or falls on the way the few customers it has are handled, although the market is now changing in that more customers and more competing suppliers are entering, following deregulation.

Hyster's senior management wish to 'beat their chests' about extreme customisation successes. This is evidence to the market generally that Hyster has the necessary technological credentials, and to the customer involved in particular that Hyster will make the effort to solve its problems. In some industries (see Honeywell above), particularly where manufacturers are keen to dramatically reduce their supplier base (e.g. Womack et al, 1990), there is evidence that it is necessary to do the 'nuisance' customised jobs to retain approved- or sole-supplier status and hence the supposedly more profitable high-volume standard business. There is little evidence that this is how Hyster's market works. Customers either always want extreme customisation

(e.g. special livery, industry-specific attachments) or never. Rarely does the 'loss-leader theory' hold out. Furthermore, as a dealer is usually involved, the customer account picture over time is obscured from the factory's view.

Customisation can also be done simply because it attracts a higher price and, potentially, a higher profit, in a purer market situation. Probably the closest to this in the cases studied were some of Letts' contracts, where they have established a minimum return they wish to make on their capacity at certain times of the year, and accept or reject jobs on the basis of their ability to achieve this minimum return or higher. Jobs are chosen on their immediate profit potential, apparently with little impact either way on the likelihood of Letts being asked to quote on future requirements.

Finally, organisations may become involved in customised or specialised products as a way of forcing themselves to develop new capabilities. Philips BCS learnt from its experience of making their Sopho-S system to the exacting standards of certain of its export market territories. At Honeywell, we see a very different outcome with the switch panel contract, the like of which they 'never want to do again' and which has added no useful transferable skills to their repertoire. However, Honeywell also provide the most pro-active example of this approach where, although it is not necessarily customisation, a particular product line is to be used as a vehicle for learning about a core technology (Prahalad and Hamel, 1990). This is perhaps an instance of logical incrementalism (Quinn, 1980) where something is tried on a small scale before being extended to be more pervasive and truly strategic.

This suggests a number of roles for customisation might be placed as shown in Table 8.12.

Table 8.12 A Range of Roles for Customised Products

Role	Entry Barrier	Vehicle for Learning	Symbol to Industry	Profit-Taker
Rationale	Product may be unprofitable but will keep competition out.	Product may be unprofitable, but new organisational or technological capabilities will be learnt	Product may be unprofitable but, suitably communicated, will enhance standing/brand in industry	Customised product attracts high price and makes profit in its own right
Timing of Benefit	Medium-term effect	Very long term	Long term effect	Immediate
Costing philosophy	Cost of account?	Indirect costs as product-line overhead	Indirect costs as general overhead	Indirect costs charged to customer per product
Volume required	Depends on balance of potential loss of revenue and cumulative effect on manufacturing costs	Enough in various/ demanding applications to accelerate learning	Minimum to achieve effect	Any profitable
Possible Manufacturing issues	Identify all costs; develop shared understanding of rationale	Capture learning and involve potential disseminators	Develop shared understanding of rationale	

This implies a significant problem of handling (Håkansson, 1982: 25), indicated by the line of the table referring to the volume of the type of business required. In the case of the 'Profit Taker', the approach would be to accept any profitable products and design the operation accordingly. Where customisation is being used symbolically

in the wider market, then the effects and intentions need to be understood clearly. If the operation is essentially inappropriate for producing heavily custom-designed products, then it would be counterproductive to actively create the impression in the market that the firm 'can do anything'. Finally, where customisation occurs in relationships with a small number of important customers, the situation with each customer and the cumulative effect on the operation of all such customers' needs must be carefully monitored, so that either a conscious change to operations can be made to support this, or the customer portfolio can be changed. (As a senior manager commented at one of the firms 'The customer is always right, but I can choose my customers...')

All these potential roles for customisation suggest different supporting or enabling roles for manufacturing and related functions. If the purpose of customisation varies from instance to instance, then the manufacturing or operation strategy that supports, enables or drives this activity will vary too. Following the foregoing analysis of a good proportion of Lett's special edition jobs as relatively pure 'market' transactions, as well as identifying the material conversion stage as of paramount importance in terms of resources and, in the final analysis, cost, it is contended that manufacturing strategy theory as represented by e.g. Hill's approach to aggregating orders and their order-winning criteria is appropriate. Although the case data are somewhat contradictory as to the effect of the relationship dimension at Letts (and restricted access did not allow comprehensive assessment of this) it is argued that less is lost in this case than in others by taking a less longitudinal or relationship-based view of their markets for customised products, and that quantitative aggregation is satisfactory.

On the other hand, it is contended that a great deal is lost by merely considering individual isolated orders and aggregating them in the way that Hill (1993) proposes in the case of, say, Honeywell, where the material cycle is a relatively small part of the interaction involved in a contract, many of the relationships with individual customers are long-standing, and there simply aren't that many potential customers (particularly for AOM products).

Considering the role of customisation also provides a link between capacity - in both production and design engineering - and the requirements of the particular type of customisation involved. This is indicated schematically in Figure 8.14.

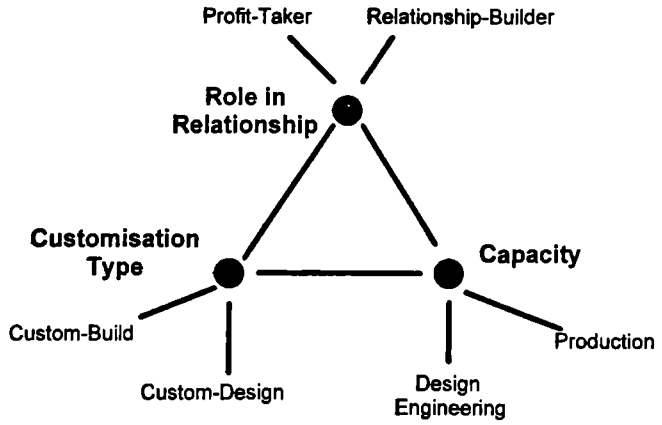


Figure 8.12 Customisation Type, Role and Capacity.

Although this figure is descriptive, it could also be used as a vehicle for analysis, insofar as there is a need for consistency of policy between the three nodes.

8.7.4 The Role of Service in Customisation

It is evident that various stages of the customisation process involve aspects that might be called services. Indeed, the shortcomings of existing manufacturing strategy theory insofar as it concentrates on volume and variety dimensions (see above) may be attributed to its inability to encompass service elements and link them to more conventional material-conversion activities. Services are:

> '...economic activities that produce time, place, form or psychological utilities...' (Murdick *et al.*, 1990: 4)

and, on this basis, the time and place benefits can be associated fairly neatly with the logistics part of the transfer cycle and, less clearly, the form and psychological benefits with the problem-solving cycle.

At the problem-solving stage, firms may be involved in extended provision of design, planning and technical services. Probably the most involved of these among the cases are the more demanding projects undertaken by Honeywell and Hyster. As discussed, the service stage has a number of functions:

- most importantly, it determines what the product and transfer specification will be and, as such, establishes the type of product customisation involved;

- it provides an opportunity for the field contact personnel to influence the

customer in problem definition;

- by a combination of the first two, it determines the organisation's achievement at the end of the problem-solving stage of the performance and features quality criteria;

- it provides service benefits - e.g. provision of engineering expertise - to the customer over and above the technical benefits provided by the tangible product to be delivered in the transfer cycles;

- it provides an opportunity to develop an understanding and possibly to influence expectations of the subsequent transfer cycles.

This linkage between problem-solving and transfer, and the permeation of service activities throughout the whole process, is in contrast to much operations management literature. Design has been treated as a transformation process (Slack et al, 1995) with its own performance objectives. But, even here, it is treated as linked to the process design activity, but not to the material cycle. In custom-design situations, such a separation is increasingly irrelevant. For example, Honeywell's designers are required to provide quotations, prototypes, and pre-production batches before full-scale production of the OEM's product. These have to be provided in a timely manner, in keeping with the OEM's project plan. This process requires iteration between Sales, Product Management, Design Engineering Procurement, Manufacturing Engineering, the model-shop (where prototypes are made) and

manufacturing itself. In the context of the relationship with the customer, it is a continuing manufacturing/service operation, which merely involves a changing proportion of service and manufacturing elements, respectively.

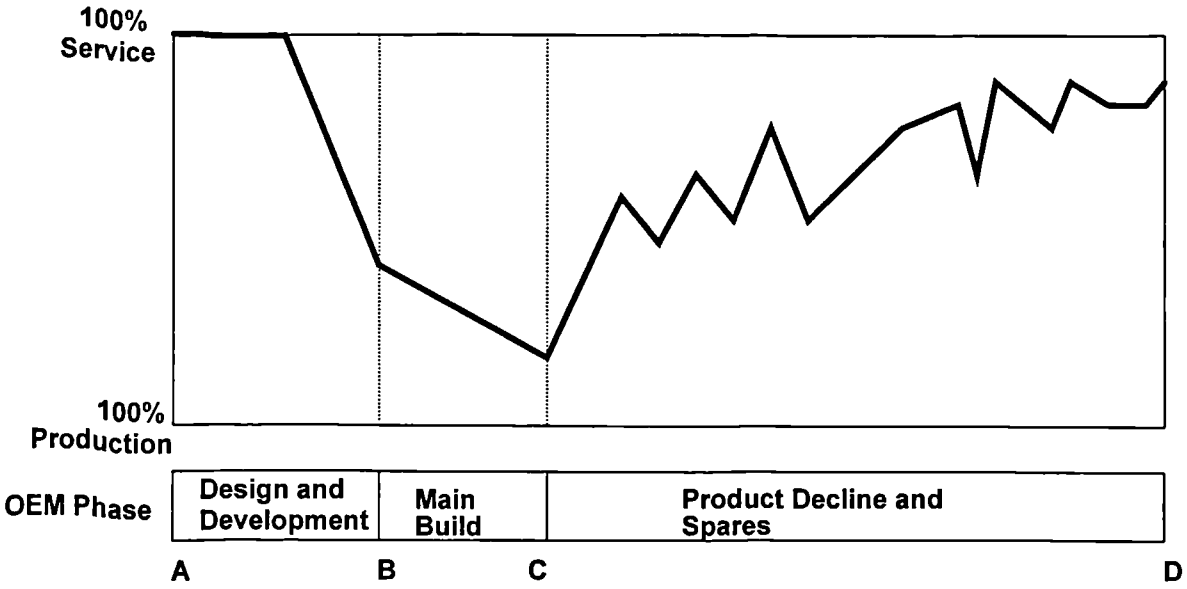


Figure 8.15 Service and Manufacturing Elements

Schematically, it might appear like Figure 8.15 over the life cycle of an OEM Project and field service life. An operations strategy might more usefully be considered to apply to the whole operation from A to D, rather than merely to the manufacturing aspect between B and C. Other cases would have different patterns over time, but all have service/manufacturing components. This then allows a contract or, on an even longer-term scale, a whole relationship with a customer, to be viewed as a gigantic service encounter. The work of Johnston (1995) shows how early stages of the service process can influence perception of subsequent stages.

A number of conclusions may be drawn from the case evidence:

- the service package is often very poorly specified and positioned e.g. Honeywell's 'we can do anything' message in the catalogue;

- the extra services are not defined or articulated at all;

- a consistent message linking problem-solving and transfer cycles that would inform any influence that may be brought to bear is absent or confused e.g. Hyster's approach to costing custom-designed products;

- means of tracking and comparing broader expectations/ performance data are missing e.g. Honeywell's inability to link original sales projects to delivery/manufacturing costs;

- unknowing provision of extra service components e.g. BCS developing system with BT in mind; Honeywell becoming materials management, test and procurement coordinators for the switch panel customer.

All in all, there are examples of services being provided with inappropriate systems and or lack of capability and, secondly, of services being provided that were not well linked and consistent with the product aspects of the product-service bundle. Without any further theoretical development, there are clear directions for improvement here. Some are indicated below:

Define the service elements: These companies would not dream of supplying a product that was not unambiguously defined, but seem to drift into half-baked service provision.

Identify performance measures: If service is a performance objective, then it must be measured in some relevant way.

Add value through the service: Depending on the specific market requirements, identify ways of adding value through service as well as through custom-designed tangible products. It is often easier to customise service than product elements.

Get involved in problem definition as early as possible. This provides more opportunities to influence what the product specification will be, as well as to influence expectations about subsequent stages.

Cost the whole process appropriately: Use an account or product-line basis for costing both product and service elements, rather than allocating a general 'sales overhead'

Price accordingly: As service elements become more clearly understood as such by both parties, they can be more explicitly sold at an appropriate price. Such discrete service elements might include design 'consultancy' , product upgrades, repairs and spares management.

8.8 Customisation and Flexibility

Customisation and product variety are conflated in many manufacturing strategy models and frameworks e.g. the product-process matrix (Hayes and Wheelwright, 1979a) and the Hill framework (Hill, 1985). However, analysis of the cases quickly reveals that customisation makes different demands on a manufacturing firm than does product variety *per se*.

Hyster's FMS- and AGV-equipped fabrication and welding system was very good at dealing with a high variety of lift-truck mast-heights - it had excellent *mix flexibility* and good *sequencing flexibility* (Gerwin, 1987). However, it only had such flexibility within a certain range and at certain increments of mast height. If customers requested non-standard options, manual intervention and/or special fixtures were needed. It had poor *modification* flexibility (Gerwin, 1987). More generally, planning of standard options was well-defined and gave good demand data for aggregate capacity planning purposes; SPED involved unpredictable demands on capacity. Thus over and above variability in general demand levels, SPED demanded additional *volume* flexibility, due to uncertainty.

Honeywell's low-capital cellular assembly processes had good mix flexibility. But the demands of frequently-novel customised products and the greater likelihood of parts shortages for non-routine and heavily forward-integrated products led to a need for additional *changeover, modification,* and *volume* flexibility. Philips BCS had excellent mix flexibility in its surface-mount assembly machine - within a certain range of

product variety. When the number of variants was increased due to the more profound implications of territory-specific requirements, the flexibility was lost. Letts had dealt to some extent with customisation by investing in desk-top publishing ('origination') equipment. This provided modification flexibility (needed anyway as products changed every year, by definition). The problem appeared to be in mix flexibility (particularly in printing), and in rerouting and volume flexibility in bindery operations.

These analyses suggest that different flexibility requirements tend to go with increased variety on the one hand, and with customisation on the other. More discriminatingly, there is arguably a difference between custom-build and custom-design products in this respect. Table 8.13 summarises this, and further adds to the argument there are different requirements for manufacturing system design when a policy of product customisation - particularly custom-design - is pursued.

Table 8.13 Type of Product Variety and Type of Flexibility

Flexibility Type	Type of Production Variety		
	Variety of standard products	Variety of custom-build products	Custom-design products
Mix	✓	✓*	
Changeover			✓
Modification			✓
Volume			✓**

* depends on product architecture

** due to uncertainty

Flexibilities determine what the characteristics of the manufacturing - material conversion - process will be, given certain conditions of variety and/or customisation. A manufacturing system with high mix flexibility will accommodate a large variety of products as though they were all the same i.e. there will be no appreciable stoppages for process tooling changeovers. This could be represented by the surrogate measure of unit variable cost, as shown schematically in Figure 8.16.

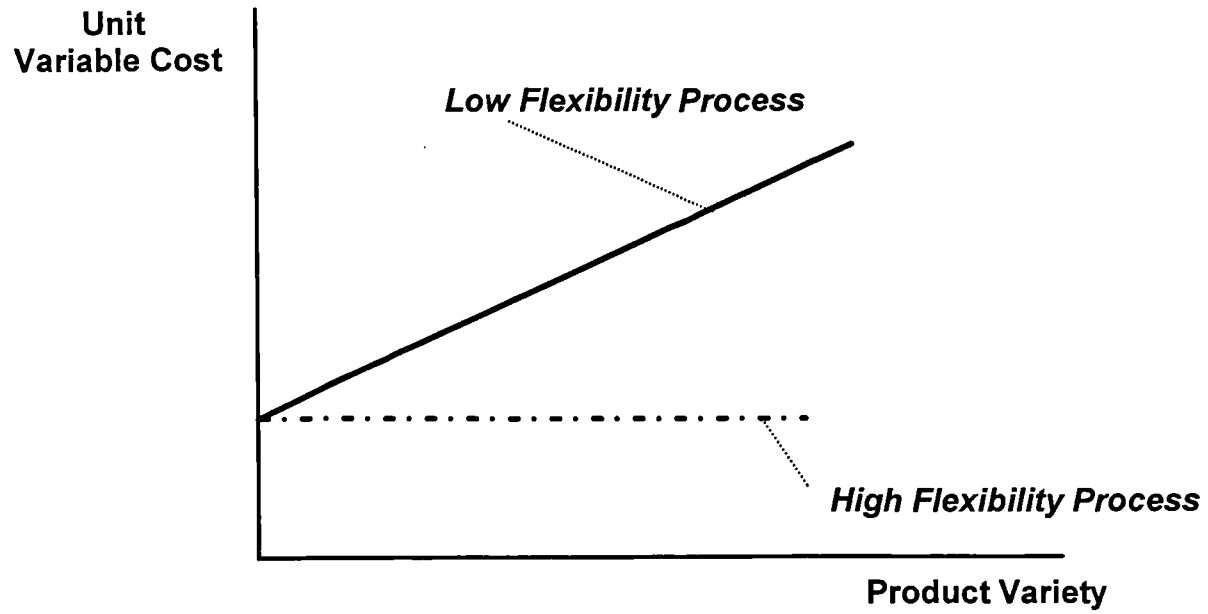


Figure 8.16 Flexibility and the Variety/Cost Trade-Off

A manufacturing system with poor mix flexibility will, for the same variety of products, incur extra unit variable cost.

Custom-designed products require an ability to change processes to some previously unused state i.e. they require, to a greater or lesser extent, a new process. This may be seen as changeover and/or modification flexibility (Gerwin, 1987). A system with poor changeover/modification flexibility will incur extra costs due to custom-design

at a greater rate than a system with good changeover/modification flexibility. For example, if the use of a CAD/CAM system meant that a parametric custom-design feature merely involves converting a dealer-input dimension into a line of code on a welding FMS, then little or no extra cost is incurred. If the same thing is achieved by manually altering a product drawing and making a new welding fixture, then this adds cost, delay and, possibly, reduces reliability of delivery.

Overall, the particular combination of variety and customisation, once translated by the system's various types of flexibility, determine the amount of and predictability of various types of activity in the material cycle e.g. process design, machine changeover/downtime and material conversion. Figure 8.17 shows this and completes the central problem-solving/specification/transfer sequence of the general model.

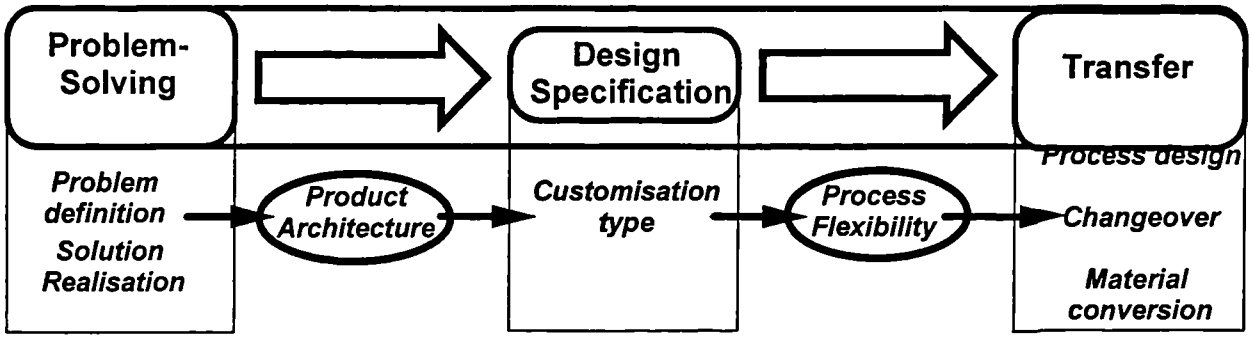


Figure 8.17 Flexibility Determines Transfer Process Characteristics

8.9 Customisation and The Trade-Off

When considering variety and customisation, we must inevitably consider the whole manufacturing system. For example, if it is held that product variety increases cost, this can only be a function of the whole product-range, not of any one product. Empirically, many of the difficulties arise due to the mixing of custom-build and custom-design products (e.g. Hyster) and/or inconsistency between various aspects of the manufacturing system. The Hyster case shows that the custom-design products have a detrimental effect on delivery speed and reliability but the effect is apparent for all the products, not just the custom-designed ones.

A useful understanding of the custom-design delivery-speed/reliability trade-off here would enable better delivery promises to be made, perhaps by some kind of product-mix index. But if the customers require faster delivery, then the next stage is to alter the trade-off: in this case, by altering the amount of custom-design by changes in architecture, by improving modification/changeover flexibility, or by adding capacity. All these have different timescales and cost implications and some indicative ways to alter trade-offs are shown in Table 8.14.

Because there is not a profound understanding of customisation, it is difficult to justify doing more than short-term 'flexing' of labour ,with all the cost and quality control implications that that has. A particular manufacturing system embodies trade-offs of one sort or another to some degree or other over particular ranges of the variables concerned. For the practitioner, it is more useful to understand the trade-offs in the

firm's own situation than to be aware of general laws or, for example, the 'sandcone' model (Ferdows and De Meyer, 1990).

Table 8.14 Type of Action to Break Trade-Off in Short, Medium and Long Term

	Period		
Issue	Short (days)	Medium (months)	Long (> 1 year)
Add Capacity	Work overtime	Add shifts Add some plant	Add shifts/ employees Major plant addition
Improve product flexibility	Ad hoc task changes	Systematic task changes Redesign recurring product elements Minor supplier development	New plant e.g. FMS Major Supplier development
Change Product Architecture	Nothing in short term	Little to be done	Redesign product lines
Cost Implications	+ variable	+ variable + fixed	+ fixed

More generally, however, the combined affect of these embodiments can be represented as connecting the transfer cycle process characteristics with the eventual performance in terms of the transfer-cycle objectives - conformance quality, delivery speed, delivery reliability and cost. Performance at this stage will depend not only on the characteristics of an individual product and the type of customisation it may involve, but also on all the other transfer cycles of all other products within the same transfer system. For example, Hyster's delivery performance was poor for all its products, not just for the heavily custom-designed products that were the cause of many of the problems. The system's ability to produce high variety (regardless of

customisation) depends primarily on mix flexibility (see above). Hence the incorporation of the trade-off into the model requires consideration of the interaction of multiple transfer cycles and of how the mix flexibility of the system makes the effect of these benign or otherwise. This is represented schematically in Figure 8.18.

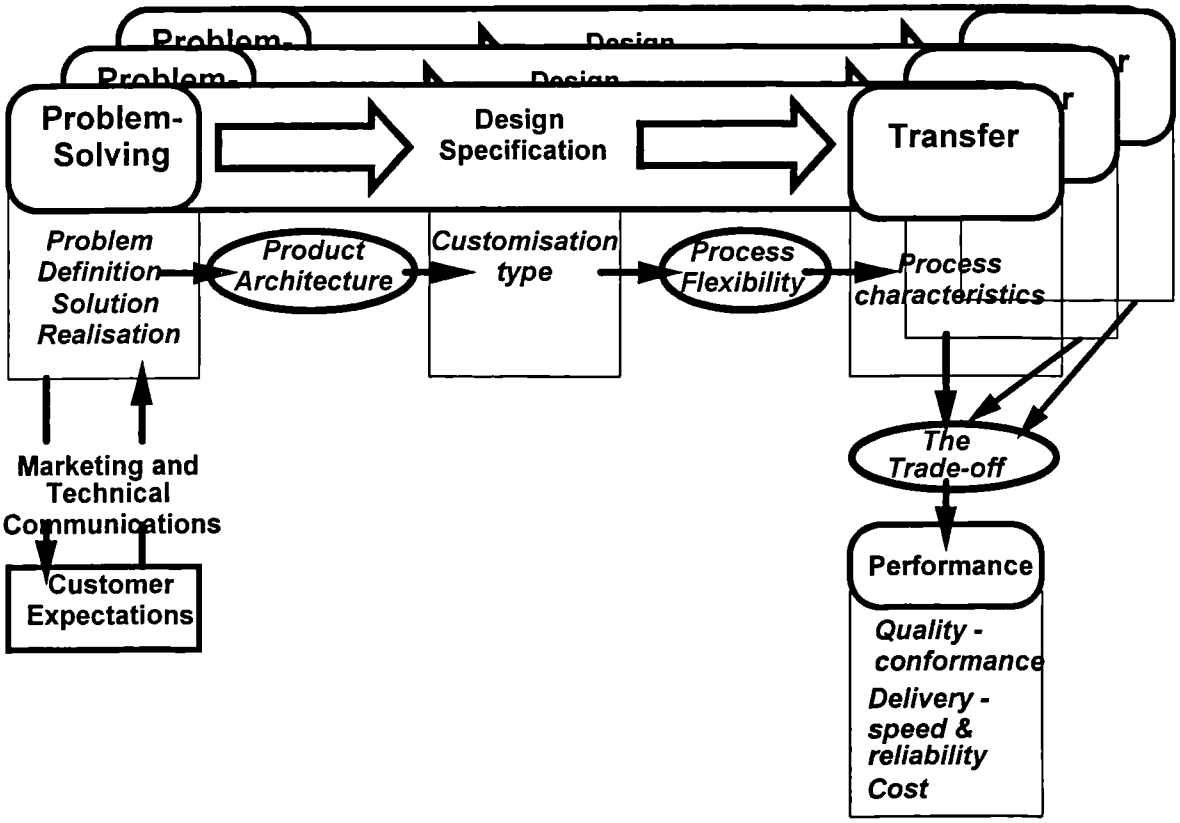


Figure 8.18 The Trade-Off Determines Transfer-Cycle Performance

8.10 A General Model of Product Customisation Revisited

The preceding sections have developed relationships between various aspects of customisation and manufacturing strategy, restated in Figure 8.19. For the sake of clarity, the model does not show multiple transfer cycles of the customised product, nor does it show that there are many other products using the same resources of problem-solving and transfer as the product modelled. These issues have been discussed earlier.

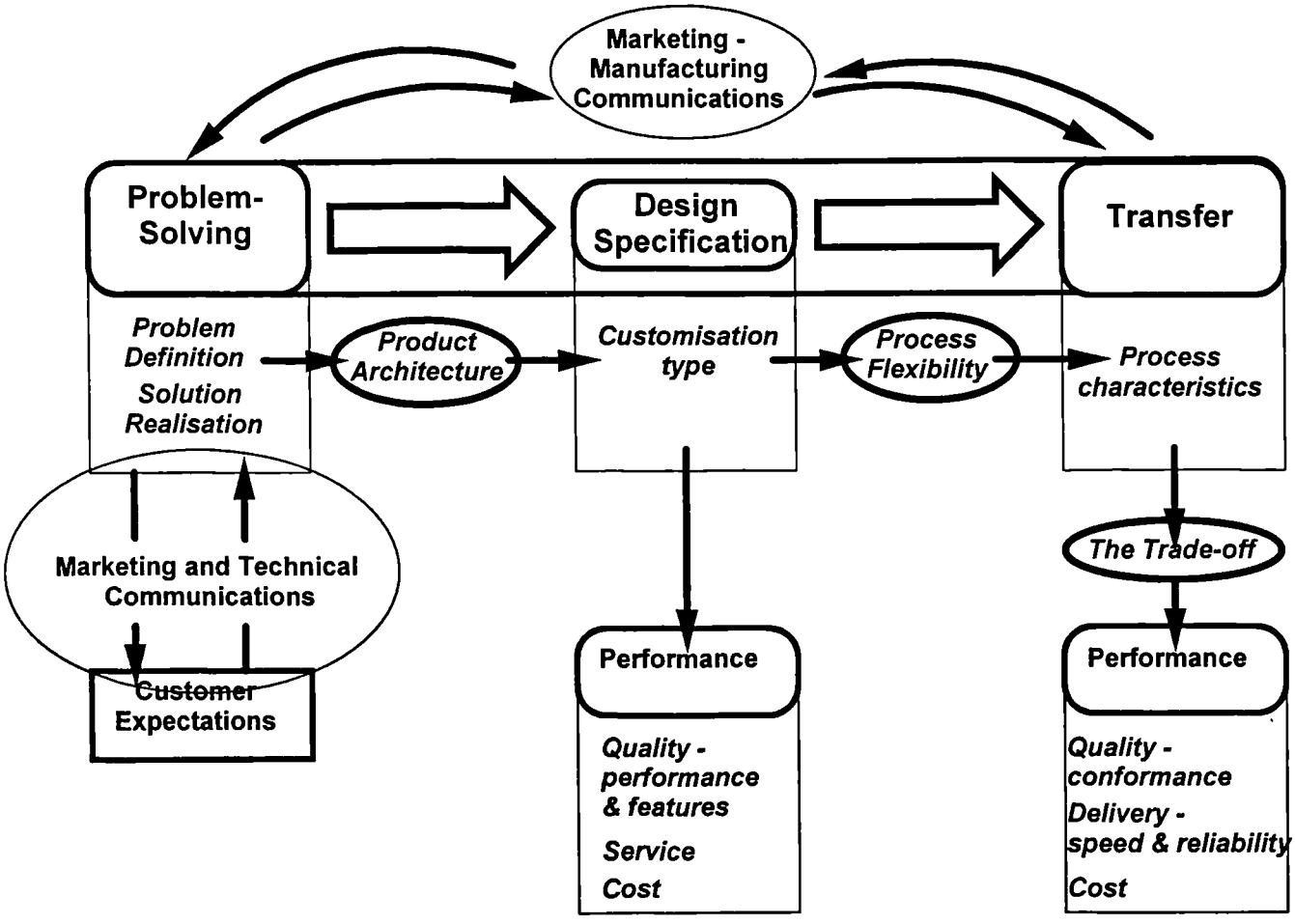


Figure 8.19 A General Model of Product Customisation Revisited

This model draws together the connections between problem-solving and transfer, product architecture and flexibility, and the manufacturing strategy trade-off and competitive criteria. In this simple static model, the 'gap' concept (e.g. Parasuraman *et al.*, 1985) can be applied to illustrate that the customer will judge whether the operation's performance meets its expectations but, from the foregoing discussion, it will be understood that the expectations are continually changing throughout the stages and repetitions.

8.11 Customisation and the Marketing-Manufacturing Interface

The research was originally motivated by apparent interfunctional conflicts between marketing and manufacturing. Now that a general model of customisation has been developed, incorporating some key concepts of manufacturing strategy theory, it is necessary to review this from an inter-functional perspective.

8.11.1 Functional Roles, Interfaces and Geography for the Firms

The diagrams in Figure 8.20 a-d summarise, for each firm, the interplay between functions and information systems in working to satisfy customer requirements. No formal modelling technique is used, the intention being to present a combination of process, organisation and geography on one diagram. These representations are built up from a combination of general descriptions of activities and procedures, and from the specific activities and contract chronologies examined.

In all the cases, there is an organisational entity in the field that is the primary contact with the end customer. Except in the instance of Letts prior to its restructuring, the other departments involved closely in most production-related activities, particularly those related to customisation, are all on one site. The organisational and geographical arrangements in the other cases had been in place for varying periods: notably BCS development and marketing staff had only recently moved onto the same site as manufacturing (albeit that they were still 'over the road' from one another). The diagrams in Figures 8.20 will provide a starting-point for examining the interactions.

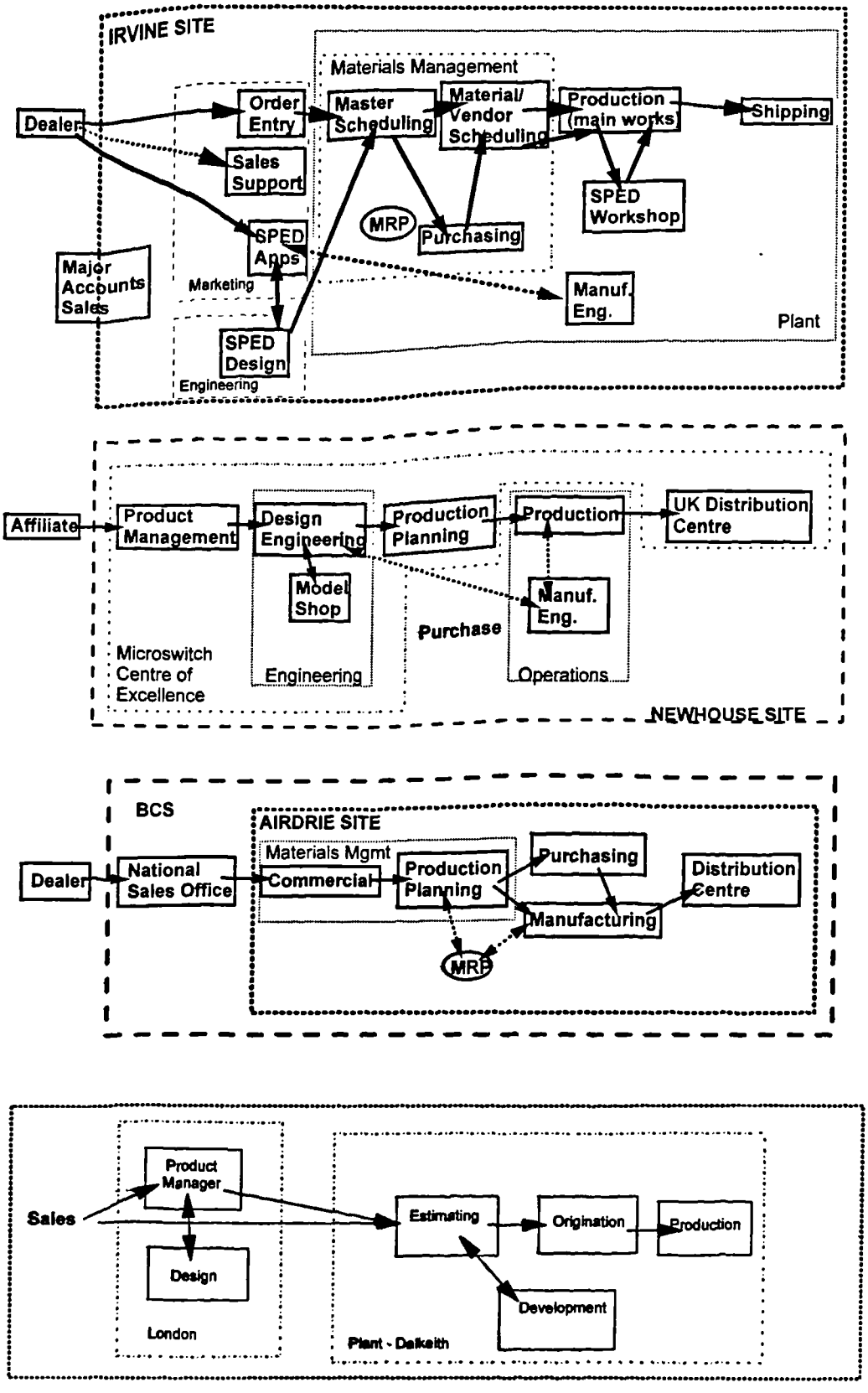


Figure 8.20 Interfaces, Functions and Geography (a) Hyster-Yale; (b) Honeywell; (c) Philips BCS; (d) Letts

8.11.1.1 Hyster-Yale

Hyster-Yale (Figure 8.20a) routinely communicate with their dealers through their computer-based specification and ordering system. For custom-built products, this drives various aspects of materials management via the MRP system, but extra complication results from the need to custom-design some part of the truck. This involves SPED Applications Engineers, SPED Design Engineers and Manufacturing Engineers. SPED Design Engineering usually need to liaise with Materials Management, to make manual adjustments to the BOM for the custom-designed options, possibly with Purchasing, to procure special parts and, just as frequently, directly with suppliers for those special parts.

The interaction with the plant is then largely indirect through the medium of drawings and customised BOMs, although it can be more direct in some cases e.g. where time pressure is particularly acute and the production process is to be designed by the shopfloor personnel at the time of production and recorded after the event. The other extra interface brought about by custom design is between the main plant and the SPED workshop, usually at the assembly stage but maybe earlier. Throughout, the materials management system and Master Scheduler play an important co-ordinating role and the MRP system and the Final Assembly Scheduling document provide a common reference-point for negotiations.

Hyster Yale see their distribution network as a considerable competitive strength. Clearly, the dealers are closely adapted to working with Hyster Yale e.g. the

extensive computer system linkages and this is not a short-term relationship. Whilst the market-based approach to distribution (as opposed to one governed by internal management of a sales outlet network) offers a number of advantages to Hyster, it also poses some problems to the plant. First of all, the end customer for a truck is often unknown, with trucks simply being identified as destined for a particular dealer branch. How much business is actually going to which end customer is information often retained by the dealer. Secondly, there is the problem of forecasting and capacity planning, particularly as it is affected by the 'evolving SPED' phenomenon.

A number of problems arose as a result of customisation, although these appeared to be accepted as a necessary part of running the plant under current market conditions, rather than merely as interfunctional mis-match. Shop-floor production management did suggest that the estimations of SPED labour content by SPED Applications were inaccurate (accusations of incompetence rather than of guile) and there was some antagonism toward dealers on the part of senior Production and Marketing management, particularly in respect of the 'evolving SPED' syndrome. The Sales and Administration Manager's lack of enthusiasm for the corporate drive to reduce leadtime to six weeks across the board were far from stereotypical. He knew what the implications would be for custom-designed products - for the most part that Hyster had no chance of achieving this delivery for them.

In summary then, the source of the considerable problems that SPED caused was located by various marketing and manufacturing personnel alike in the court of the dealers and, in the case of one major account contract examined, the occasionally

inept management of the contract by the customer.

8.11.1.2 Honeywell

Honeywell's structure is slightly unusual in that marketing and engineering activities for all microswitch products were the responsibility of the Centre of Excellence General Manager (Figure 8.20b). The Centre ensures close collaboration between marketing (in the form of Product Management) and design engineering. They are located next to one another. As noted, the Product Manager spends some time in the field but, as a result of the gradual erosion of senior managerial and technical support at Newhouse, found the need to stay at the plant more than he would like. His affinity with the plant was demonstrated in describing his own desire for 'more business, of the business we want', and in his envy of the high-volume, low-cost production in the US AOM facility. This was evidently due to the ability of that plant to steal European business from Newhouse on account of lower costs, as much as to natural empathy with the lot of the production staff.

Although there was some gentle criticism of the engineering staff for relatively poor documentation of projects, for the most part the Product Manager (the main respondent) gave the impression of their all being in it (the low-volume, highly customised business) together. The main criticism was once again reserved for the field: they give poor and incomplete information when they request special products, they ask for quotes based on one projected volume and the order turns out to be for

ten percent fewer, they do not understand the technical implications of what they are asking for and they threaten Newhouse with withdrawal of the business to the US if designs are not ready, prototypes not made, or orders not delivered. This pseudo-competitive behaviour occurs despite the fact that the sales affiliates are nominally part of the same firm.

8.11.1.3 Philips BCS

Philips BCS is somewhat different insofar as there is no explicit customisation and so the pattern of some design or problem-solving activities being driven by enquiries from individual customers that exists elsewhere does not apply, although expectation of considerable sales to one customer, BT, strongly influenced the design of the Sopho-S product.

Philips BCS interactions are shown in Figure 8.20c. The Commercial and Forecasting Manager coordinates various levels of forecasting based on NSO/dealer projections. These are used to develop detailed business plans at individual model level, month-by-month. Systems and terminals are produced on a make-to-stock basis with production rates set via the Master Production Schedule and exploded into purchasing and manufacturing requirements by the MRP system. Products are shipped to the newly-established centralised warehouse.

It is evident that the closeness that exists between marketing/applications engineering

and manufacturing at Hyster and Honeywell does not exist at BCS. Nowhere among marketing personnel is there the concern for what 'sort of business' a project represents for the plant, unlike at Honeywell: the business plans for the larger-scale projects appear to take no account of manufacturing costs, and the Design Review process has compulsory representation by marketing, but not by manufacturing. The programme of Design-For-Testability training for development engineers was, however, one example of an attempt to build considerations of manufacturability into the product design process.

The recent development of the dealer channel has placed the emphasis in marketing on sales channel management rather than the more integrative technological and business perspective in evidence, at least occasionally, elsewhere. Nor was there any evidence of a potentially-compensating closeness to the dealer network - in the development of particular overseas variants, for example, there was often very little cooperation, commitment or useful information forthcoming from the dealer.

Probably the most important point about BCS's dealers is that they have 'no supplier loyalty' and offer competitor products. They are variously described as 'into features' and 'cash-flow oriented'. Once they have secured an order for a system they are keen to ship the product and receive payment, so delivery speed and reliability would seem to be a way of maintaining the dealer's interest in promoting the suitability of BCS systems against those of competitors. Thus, although end users may not be so concerned about rapid delivery, the dealers are, and this channel relationship affects the plant's priorities.

8.11.1.4 Letts

At Letts, the situation changed radically during the period of the research. At the outset, one of the reasons for interest was the perceived gulf between, on one hand, the London-based, metropolitan marketers and designers and, on the other, the production plant, located on an industrial estate on the edge of Edinburgh and operating according to a 'civil service mentality'. The research was interrupted and, in the end, truncated by the closure of the London office and relocation of some of the staff to Scotland.

The interfaces within the plant (Figure 8.20d) were overshadowed, during the initial research phase, by relations 'with London'. The responsibility for 'design' was much more diffuse than in the other firms. So, whilst control of Editorial Design - verbal and graphical content of printed material - was clearly the province of the Editorial Supervisor, responsibility for design of, say, diary cases was less clear-cut. Procurement were involved in identifying materials; there was some activity nominally called 'design' in London (Editorial had been based there until a few years previously) and at least one Dalkeith manager commented on the lack of 'product engineering', a term which appeared to have Letts-specific connotations of design-for-manufacture. The Technical Evaluation Committee (to choose one of the names by which it was known) appeared to have some ad hoc coordinating role for more extreme products. Letts seemed to lack the product-technology focus that, at other firms, helped interaction between functions. The technological focus was on process technology in general and printing in particular.

The situation at the end of the research was very different, of course. The Business Planning Committee had taken over as the principal coordinating mechanism.

8.11.2 *Can* Marketing and Manufacturing Co-Exist?

In many ways, the taxonomies of the conflict areas identified by the authors in section 2.4.1 of the literature review are of relatively little use in evaluating the data. The crassly stereotypical issues they present are not, on the whole, those with which the people working on the marketing-manufacturing interfaces are preoccupied. Of course, this is not to say that some of the types of conflicts of interest don't occur. For example, Hyster's capacity planning is made difficult by their dealers' tendency to commit to buying a certain number of trucks, but to change their specification from 'standard' to 'special' at the last minute. Letts Marketing have procured sample and even production-quantity materials without involving manufacturing staff at all, until the day the products are to be made. But for all such examples, there are just as many examples, if not more, of counter-intuitive and subtler incidents and perspectives.

Hyster's Sales and Administration Manager is sceptical about the need for the 'corporate push' to shorten delivery lead-time. He is aware of a trade-off between fast delivery and customisation and, in so being, is in accord with the Plant Manager. Honeywell's Product Manager is disgusted with the Sales Affiliates who provide what turn out to be inaccurate order volumes against which to quote prices. Philips BCS Manufacturing Manager is disappointed with the apparent inability of Marketing to

stake out a clear competitive position, but most of the discontentment of the more junior manufacturing management is with the Development staff, for designing products that are difficult to test and for what they perceive to be poorly-run development projects.

What emerges then, is that there is no homogeneous 'Marketing' that interacts with and conflicts with a similarly uniform 'Manufacturing' at the (single) interface between them, but widely different views within functions, poor interactions with functions other than marketing, as well as within the functions themselves. The following section seeks to identify the patterns of interactions that do occur.

8.10.3 The Field-Plant Interface

One interface evident in all the diagrams in Figure 8.18 is that between the organisation at the plant and the operation in the field - whether this be an independent dealer, a wholly-internal sales organisation, or something in between. It is useful to note how, in each of the cases, this interface is constituted.

Hyster-Yale have independent but sole dealers. They agree volume targets with the plant but are at considerable liberty to change composition at short notice. Their income depends on sales revenue. At Honeywell, the salespeople are Honeywell employees, but part of a separate division of the firm in Europe; they can and do play off US plants against UK where both make a required product. For each territory served by Philips BCS, a National Sales Office now acts as local administrative focus

for independent dealers offering Philips as well as direct competitor products. Dealers are 'cash-flow-oriented' and 'into features'. Letts use a combination of general and key account salespeople, all of whom are Letts employees. These arrangements are summarised in Figure 8.21.

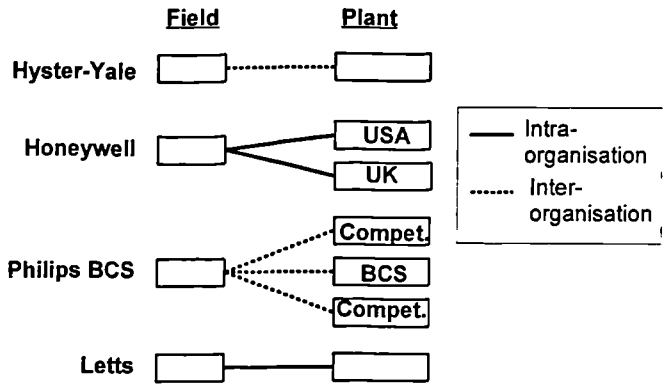


Figure 8.21 Constitution of the Field-Plant Interface - Ownership and Competition

The differing approaches to governance and organisation of the field units led to different patterns of behaviour and levels of consistency between the interests of them and those of 'the plant'. The staff in the plants of some of the firms were concerned that the exclusivity of the field entity's contact with the end customer was detrimental to their (the plant's) ability to understand customer requirements. Hyster-Yale, as has been discussed, often did not know the identity of the customer for whom they were doing customisation work. Customer contact often took the form of a dealer-mediated request for an applications study i.e. a paper exercise. Sometimes, the request necessitated a customer visit by Sales support or Applications engineers, in which case much richer knowledge was possible. At Honeywell, all Sales Project requests were for identified customers and it was common practice for the sales affiliate to

involve product management and (prior to their being made redundant) design engineering in customer visits. Philips BSC had very little direct contact with their small business users, but maintained close contact from marketing and development departments with major PTT customers. Sales and marketing personnel were Letts sole contact with their retail and Special Edition customers.

The relationship spanning the geographical boundary between the plant and the external entity in contact with the customer recurred in the cases as a dominant influence on operations - more so than the boundary between marketing and manufacturing functions that is emphasised in a literature predisposed to abstraction and the neglect of the concrete and spatial. It was also *particularly acute* when the custom-design of products was involved. The important characteristics of this relationship appear to be ownership, mutual exclusivity (i.e. competition) and the potential for direct involvement of plant-based staff with the customer - see Table 8.15.

Table 8.15 Some Features of the Channel Structures of the Firms

Firm	Field Entity Owned by Plant	Unique Field Outlet	Unique Manufacturer	Direct Plant-Customer Contact Normal
Hyster	X	✓	✓	X
Honeywell	✓	✓	X	✓
Philips BCS	X	X	X	X
Letts	✓	✓	✓	X

8.11.4 Major Accounts

Some of the firms have differentiated approaches to dealing with major customers. Hyster-Yale have quite recently established a key account sales subgroup, where customers with high or potentially high spends deal directly with the firm rather than with its dealers.

Honeywell worked in an extraordinarily concentrated market (Blois, 1980a). As such, there was no special treatment for major accounts as, although clearly some customers were considerably more important than others in terms of revenue, there were no 'routine' AOM customers and considerable affiliate time and energy was devoted to all accounts.

Despite its move to independent dealers, BCS retained direct contact with major PTTs e.g. BT in the UK. This is an issue which betrays a certain schizophrenia within the BCS operation. It was accustomed to operating almost as a BT (then British Telecom) manufacturing plant, working closely to develop products with a considerable emphasis on high specification and less concern about cost. These were products designed infrequently, to be produced in considerable volumes (particularly the basic telephone) and to last for many years in the field. Only recently had BCS any experience of designing products *for anyone else*. There is considerable evidence that the new product-line, Sopho-S, was also originally conceived of as a product essentially for BT that would also be suitable for other customers, although accounts as to its 'truly international' status varied between respondents and, apparently, over

time. In any event, BT did not, as anticipated, order large volumes from the launch of the product. Hence, rather than the independent dealer channel complementing the sales through the direct, major account business with the familiar face of BT, it was the independent dealer network that constituted the majority of the new business.

Despite that, this unexpectedly sharp shift in the customer base left the Airdrie plant very exposed when its in-house sales channels were eliminated at the very time when it needed good intelligence about its many new and very different - different from each other and different from the familiar - markets. We have already seen the way that consistency between functions and over time about competitive emphasis was missing. As the research drew to a close, it seemed likely that BCS would begin to supply BT with the new Sopho-S product, with an attendant shift in focus back to the major account marketing approach with which it was familiar.

Letts certainly used key account managers and more general salespeople, but it was not possible to determine the relative importance of these overall or in the separate retail and special edition markets. Certainly though, the very large retail accounts such as that of W.H. Smith were given special treatment.

8.11.5 The Effects of Customisation on the Manufacturing-Marketing Interface

Custom-design necessitated extra channel complexity. There are more stages in the process, more interfaces between functions or groups, more uncertainty and a need for more communication of a less structured nature. This applies particularly to problem-solving, but also to transfer.

One interpretation of the idea of a 'marketing-manufacturing interface' might be the direct transfer of information, products or materials between the two functions. A slightly closer examination of the way in which the firms carry out the process summarised in the general model of Section 8.9 quickly shows that this interface *doesn't exist* when firms are involved in custom design. It is more clear cut in some cases than in others but, at Hyster for example, for a custom-built product the dealer communicates directly with materials management via the Sales Order computer system; for a product with custom-*designed* elements, Applications Engineers (nominally in the marketing function) communicate with manufacturing via the Design Engineers - part of the Technology function. Likewise at Honeywell, although there was always some involvement of the Designer Engineers, for the more involved projects they played a major orchestrating role in making the connection between marketing (Sales Engineer and Product Manager) and Manufacturing (Production, Production Planning & Control and Procurement). Similar linking roles were played by the Development department at BCS and the Technical Estimator and Origination Department at Letts.

There *is,* however, considerable interaction between marketing and manufacturing in the transfer cycle. This almost always centres on capacity planning & control and the short-term management of delivery performance. This is typically a three-way communication with Sales on the one hand (and it is usually sales rather than marketing), Production Management on the other and Materials Management or some equivalent in the middle. The only case where the materials management function was part of manufacturing was Hyster; in all the other three, materials management was a separate function, reporting to the MD or equivalent.

What seems to emerge from this analysis is that the marketing-manufacturing interface is a very fragile concept in most circumstances. There is little direct communication, as a matter of procedure, between the two functions. In the transfer cycle, there is some evidence that appropriate use of materials management systems can provide a forum for a debate; in the problem-solving cycle though, before The Marketing-Manufacturing Interface is identified as the problem, *perhaps it would be a good idea to try having one.* Where custom-design is commonplace, although certain technical skills and standards are clearly necessary, it is not necessary to have designers working within a separate function - engineering or similar. The Hyster SPED Design Engineers working for the Production Manager would be a positive move. A Technology function that remained guardian of engineering standards and carried out longer-term design work e.g. major NPD would still have an important role to play. Letts have, by virtue of the routine nature of product revision, moved the origination department from London to Dalkeith and incorporated it within Production. This, particularly combined with the co-location of Product Management at Dalkeith,

appears to be a step in the right direction. The organisational and attitudinal distance between the BCS Development engineers and the plant ('over the road' is a long way) is proving to be a difficulty as product change becomes more frequent and profound than had been anticipated. All in all, the conclusion is that the incorporation of product engineering into manufacturing, both organisationally and strategically, is highly appropriate where custom-design is commonplace and, in particular, where repetition of the transfer cycle is low.

8.11.6 Staff Backgrounds and Degree of Specialisation

The role of design engineers in bridging the gap between marketing and manufacturing during the problem-solving stage is related closely to the mix of skills and disciplines present among staff in different functions. For example, at Philips BCS the marketing staff, production staff and development staff, certainly those interviewed, are from more divergent backgrounds than at any other firm. The development engineers are specialist engineers and were recruited and trained as such; the marketers are from various academic backgrounds, but certainly not production (the three main respondents were from marketing and physics backgrounds); the production staff, even production engineers, are long-established in that department. This may result from the technology of the product, in that design and development requires such a high degree of specialist knowledge and skill that it is essential to recruit specialists in those areas.

The recent move to channel management in Philips BCS marketing requires and develops a different set of skills and priorities than the type of marketing at Hyster, Honeywell and Letts. At these firms, the roles of product managers, applications engineers and designers are much less disparate. All are involved in technical problem-solving, most have been through similar experiences: the Honeywell Product Manager was previously a design engineer; even the much maligned sales engineers at Honeywell were all from an engineering background; a key role in the commercial estimating and process planning section at Letts was played by a time-served printer who had worked on the shop-floor for some years; all technical aspects of Hyster products were the province of professional engineers, either in design or applications engineering. Whilst the commercial decision-making, especially at Honeywell and Hyster, appeared to be under-developed, at least there is some evidence of empathy between the plant-based engineering and marketing personnel and the production staff. At Philips BCS, there appears to be neither this type of mutual understanding nor any convincing mechanism by which commercial decisions about product additions might be made.

Frequent custom-design work, then, seems to require a common foundation of broad-based product technology knowledge and experience. However, this must be checked by a clearly articulated business rationale and objectives, so as to guard against the tendency of engineers to become fixated by the technology and forget whether what they are doing is good for the business as a whole.

8.12 Operations Strategy and Customisation

The analysis so far has identified a number of shortcomings in the manufacturing strategy literature. These will be reviewed and a new approach to operations strategy for manufacturers will be proposed.

8.12.1 Some Shortcomings in the Manufacturing Strategy Literature

8.12.1.1 Omission of Service Component in Manufacturers' Offerings

This literature has taken to 're-badging' itself as 'operations strategy' (e.g. Anderson, Cleveland and Schroeder, 1989), but a good deal of it is still founded in manufacturing-based empirical work. Some applications of the basic concepts to service situations are discussed, but manufacturing predominates, and service/manufacturing situations are treated dualistically i.e as either one or the other. What the research here suggests is that customisation may require that the whole problem-solving and transfer process be thought of as one product/service 'bundle'. It has been difficult to identify whether the sales engineering activity is best thought of as marketing or as a service operation. In the end, this turns on whether or not the customer pays for the service, as trying to distinguish on the basis of the nature of the activities is fruitless. But, particularly in relatively stable industrial marketing relationships, the focus moves away from the 'piece price' for a product. Hence, it is increasingly understood by both parties that the problem-solving activities generate

cost in the relationship and, on this basis, can more appropriately be though of as service operations. This leads to the conclusion that a genuine *operations strategy* capable of treating any combination of product and service is required.

8.12.1.2 Neglect of Design Engineering Activities as Central to Operations

Manufacturing strategy has accommodated the NPD (New Product Development) process to some extent in adding 'new product development' to the decision areas (e.g. Hayes, Wheelwright and Clark, 1988). 'Innovativeness' is a competitive criterion (Leong et al, 1989). But this is an awkward accommodation, with a strong taste of the afterthought. These cases show that design and product development is not an infrequent activity, aberrant from the 'true' operations activity of *converting material;* rather, for various reasons, it is *central* to many operations, as shown in the model of section 8.10.

To accommodate this concern, and that relating to the inclusion of service elements, requires a change to the boundaries from marketing/manufacturing or design/production. An alternative view is proposed in Figure 8.22, which is a simplified version of the general model of customisation. This draws a boundary between front-office and back-office activities (Silvestro et al., 1992). This approach brings design (solution realisation) naturally closer to the manufacturing part of the transfer cycle and automatically includes, on an equal footing, the service elements of the process.

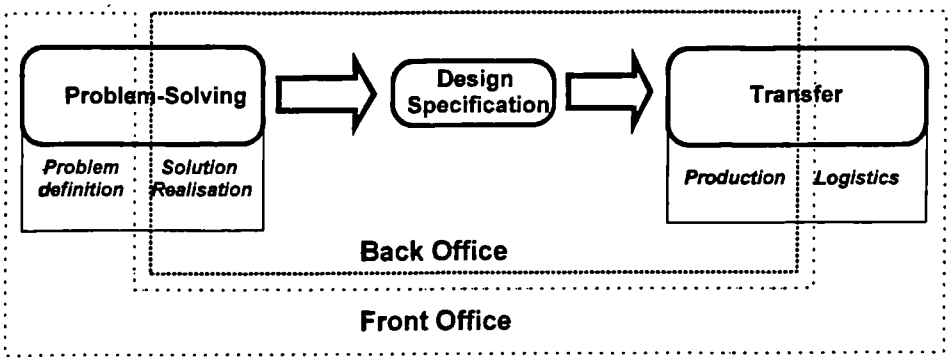


Figure 8.22 Problem-Solving and Transfer: Front-Office and Back-Office

8.12.1.3 Over-Emphasis of Pure Markets

The analysis of the roles of customised products and of the variety of channel structures indicates that a manufacturing strategy theory that assumes that any plant is selling products into a 'pure' market has serious limitations. As already discussed, relationships make it more appropriate to think of the whole process as a service operation (see 8.11.2). In addition to this, different roles and rationales for customisation require different bases for strategic decision-making.

8.12.1.4 Lack of Precision in Including Customisation, Flexibility and Trade-Off

Considering customisation highlights the lack of precision with which concepts such as flexibility and the trade-off, as well as 'customisation' itself, are often deployed in the manufacturing strategy literature more generally. The foregoing discussion has highlighted the ways in which different types of customisation require different forms of flexibility, the trade-off can more usefully be though of in terms of its embodiments, and that care in identifying the types of customisation can be very revealing.

8.12.2 An Operations Strategy Process

This section sets out a proposed strategy process based on the foregoing assessment of the issues raised by customisation. The approach is fairly conventional in structure, in that it involves analysis of past activities and projections of future market requirements, assessment of current resources and capabilities, and the formulation of appropriate process and infrastructure. The novelty lies in what is considered at each stage. Here there is a marked departure from other manufacturing strategy approaches. Table 8.16 summarises this process, and the sequence of decisions is structured around the general model of customisation.

Table 8.16 An Operations Strategy Process for Customisation

Process Stage	Model Insights	Strategic Analysis	Strategy Prescription
Problem-definition/ customer interaction	This is a service. It can influence expectations. Early involvement is vital.	Analyses customer relationships: - What is role of customisation? - How mature is relationship? - Value and prospects for growth? - What are customer-specific drivers of customisation?	Design service explicitly Define performance measures consistent with strategic role Develop policy on role of customisation based on degree of market concentration
Problem-solving cycle	Amount and novelty of problem-definition vs solution realisation will vary This is the front-office/back-office interface	What are patterns/projections of problem-definition vs solution realisation activity? What are the cost-drivers of each? What are the patterns of communication?	Design organisation and information system to promote integration at most important links. High levels of activity require integration of people i.e. do not depend on arms-length dealers where information is rich. Product Manager role may be key - but must be clearly defined.
Product Architecture	Determines translation of benefit dimensions into specification	What are the dimensions that are provided by the platform? optional features? essential features? custom-designed elements?	Architecture must reflect trends and projections in benefit dimensions required. Architecture must accommodate 'emergent local standards' due to e.g. geographical peculiarities

Table 8.16 contd An Operations Strategy Process for Customisation

Process Stage	Model Insights	Strategic Analysis	Strategy Prescription
Specification	Defines type of customisation and hence performance and features quality, service and cost of problem-solving. Some performance measures determined at this stage.	How well can designers provide performance/features that customer wants? How good at service? What does it cost?	Communicate appropriately: - to customer and sales channel to maximise impact of service element and recover any service failure - internally to promote on-time delivery and good conformance quality
Process Flexibility	Type and manufacturing labour content of customisation determines flexibility type	What has been/is anticipated to be the pattern of customisation type? What types of flexibility do these demand? Does operation have them?	Provide relevant flexibilities Develop consistently with architecture.
Transfer process	Traditional volume-variety still important, but also capacity,capability and uncertainty implications of custom-design	Is process and infrastructure appropriate to volume-variety? How reliably and effectively are novel specification aspects of customised products communicated?	Integration of design engineering via organisation and information systems is important when custom-design is frequent and involved.
Trade-off	Where process stages are shared, custom-design trades-off with delivery performance for whole of output. Embodiment of trade-off is more use than general laws.	Identify manufacturing process stages where customisation-related trade-offs are embodied.	Either adopt focus to separate custom-design from standard production , or address trade-off issues such as capacity and product architecture. Identify long-term trade-off issues anyway.

The general model links customisation to established manufacturing strategy concepts. The novel feature of this strategy formulation process is that new issues are identified which, cumulatively, have strategic impact on manufacturing. The table links issues with stages in the process, but over-arching strategic concerns are as follows:

- what is the role of customisation in our relationships with our customers?

- how much of the customisation can and should be achieved through the product, and how much through customised service?

- what approach to costing of the problem-definition, solution-realisation, and special manufacturing activities should be adopted?

- what combination of product architecture and process flexibility will provide the level of customisation required?

- what are the embodiments of the trade-off that have a particular bearing on the ability to provide customised products, and how can they be reduced or eliminated?

- what is the most appropriate channel structure to provide the necessary coordination between stages at the lowest overall cost?

These strategic decisions will be made on the basis of important data about the past, current and future market/customer requirements. Exactly how these data are collected is beyond the scope of this work, but they will include:

Customers: How concentrated are and will be the markets? How stable is the relationship with the portfolio of customers? What have been, are now, and are likely to be the important benefit dimensions that are (a) common to all customers and (b) differentiate them? Do customers order both customised and non-customised products?

Problem-solving: What is the level of work involved in problem-definition and solution-realisation, respectively? What customisation types have been needed to satisfy customer requirements? How well have specifications satisfied performance and features quality criteria? How long does each stage take? Has it been quick enough?

Transfer: What volumes are produced over what time period? What delivery speed and reliability have been/will be required? How good is performance quality? Can expectations and planning of transfer cycles be influenced by developing closer customer relationships?

The practitioner is advised to collect data on these customer- and market-related issues, to analyses the firms' processes using the general model as a reference-point, and to adopt the policy guidelines of Table 8.16, which acts as a summary of most of Chapter 8.

Chapter 9

Conclusions, Speculations and Recommendations for Further Work

9.1 Introduction

This Chapter will begin by reviewing the research questions and assessing whether they have been answered. It will then discuss the extent to which the findings here may be generalised outside the cases examined, and comment on the suitability of the research method.

Following from this, the chapter will examine a number of issues that, although less thoroughly grounded in the data, nonetheless appear to offer potentially powerful insights. Then, to some extent connected to this, the chapter concludes by proposing a number of further areas of work that follow from this research.

9.2 The Research Questions Revisited

The research questions are reviewed one by one.

How can manufacturing strategy theory be extended and modified to accommodate product customisation as a central, rather than peripheral, issue?

The general model links a number of important manufacturing strategy concepts with customisation. The strategy implications, reviewed in section 8.12.2, but developed throughout much of Chapter 8, indicate what extra strategic concerns exist, what data

are required, and what courses of action are appropriate.

How do deliberate and emergent strategy formation processes involving manufacturing and other functions, notably marketing, determine firms' success in producing customised products?

It is clear from the cases that the deliberate strategy formulation processes adopted by the firms hardly take account of customisation at all. Furthermore, nothing provided by the manufacturing strategy literature provides for it convincingly. The emergent strategy formation process appears to accommodate gradually more and more custom-design, with many individual decisions, often by technology staff such as design engineers, cumulatively leading to a drift toward customisation with no clear business rationale and no long-term changes in process or infrastructure to deliver this more effectively.

In this context, what are useful dimensions by which to define, and against which to change, the business?

The cases have enabled the identification of a number of variables which, under certain circumstances, are more important than the often market-oriented variables typically used to characterise businesses. Products and markets may come and go, but whether a firm is a problem-solver or a transfer specialist, network and information

coordinator, or an operator in close or transient relationships, determines a good deal of its organisation and priorities. It appears to be difficult and slow to change and, by the same token, for competition to emulate.

To what extent and in what ways are problems of customisation associated with the conflicting requirements of marketing and manufacturing and, if these are significant, how might they be addressed?

It has been found that Marketing and Manufacturing are not the inevitably-diametrically opposed functions that some of the literature would suggest they are. Customisation, particularly custom-design, introduces a technical design stage between the sales and marketing and the manufacturing activity. The relationship between the external sales entity - sales engineer or dealer - and the plant appears to be most consistently strained. Negotiation and conflict may then arise over priorities in the transfer cycle; this is essentially an issue of capacity management.

Does manufacturing strategy theory take account of the distinctive characteristics of industrial markets? If not, how could it be modified to do so?

The answer here is a fairly resounding 'no'. The stability, maturity and mutual exclusivity of relationships with customers is a crucial factor in determining the most appropriate operations strategy in many of these cases; this is neglected entirely by

manufacturing strategy theory. Chapter 8 identifies some of these issues; the sections below explore this further.

9.3 Generalisability

The external validity of this work is founded, first of all, on the internal validity of the individual cases. The availability of different types of data (e.g. detailed quantitative data at Hyster-Yale) influenced the extent to which triangulation could take place. Despite these variations, however, it is felt that this was possible in the first three cases if not all four.

The factors that influence the changes in manufacturing strategy, the interfunctional relationships and, indirectly, customisation are prevalent in many industrial sectors. Where these relata exist in cases outside those studied, then the types of patterns experienced in the case-study firms have the potential to happen (Sayer, 1992). Each new case must be treated as unique, of course, but some notable contingent factors that are likely to give rise to similar events are:

- internationalisation of markets
- maturing products
- rapidly changing product technology
- vertical dis-integration
- OEM projects over long time-periods

- closer relationships in industrial and retail markets
- industry over-capacity.

9.4 Research Method

The case-study method has been invaluable in identifying, in a more discriminating way than hitherto, the subtle but often significant aspects of the research problem. Because many of the issues that have emerged as important have been so in an indirect or cumulative fashion, it doubtful that an extensive approach would have identified the phenomena at all, let alone made it possible to understand how they were inter-related.

The changes that took place even in the short duration of the case-studies made the work longitudinal in nature, almost by accident. If the work were to be repeated, the most significant change would be to adopt a more explicitly longitudinal approach from the outset.

Despite the regrettable length of this thesis, there is still a good deal left unsaid. There is no doubt some bias in what has been included and what has been left out. But the approach adopted, of writing relatively 'free' analyses of the individual cases, then carrying out an analysis in Chapter 8 more closely structured by the literature review, has been a useful way of approaching the data 'from both directions' and strengthening the arguments.

9.5 Tracking Past and Present Influences on Strategy

The majority of the research effort was devoted to understanding and quantifying the current situation. As such, a variety of influences presently acting were identified. However, the research also confirmed Pettigrew's comments on strategy process research:

> 'There is the looming presence of the heavy hand of the past. History is crucial. Antecedent conditions shape the present and the emerging future. But history is not just events and chronology, it is carried forward in the human consciousness' (Pettigrew, 1992: 10)

This view is at variance with much of the manufacturing strategy process literature which disregards the past, assesses the present performance, projects the environmental future and designs the organisational future that best 'fits' (e.g. Schroeder and Lahr, 1990; Platts and Gregory, 1990; Hill, 1985, 1993).

Although the prescription of Chapter 8 concentrates on analysis of recent activity, analysis of the cases in the spirit of Pettigrew's comment (above) is potentially very revealing. This is in keeping also with the *purported* approach of Hayes and Wheelwright (1984: 30), although theirs is a stress on merely *observing* patterns in actions, not understanding them in the way that Pettigrew attempts.

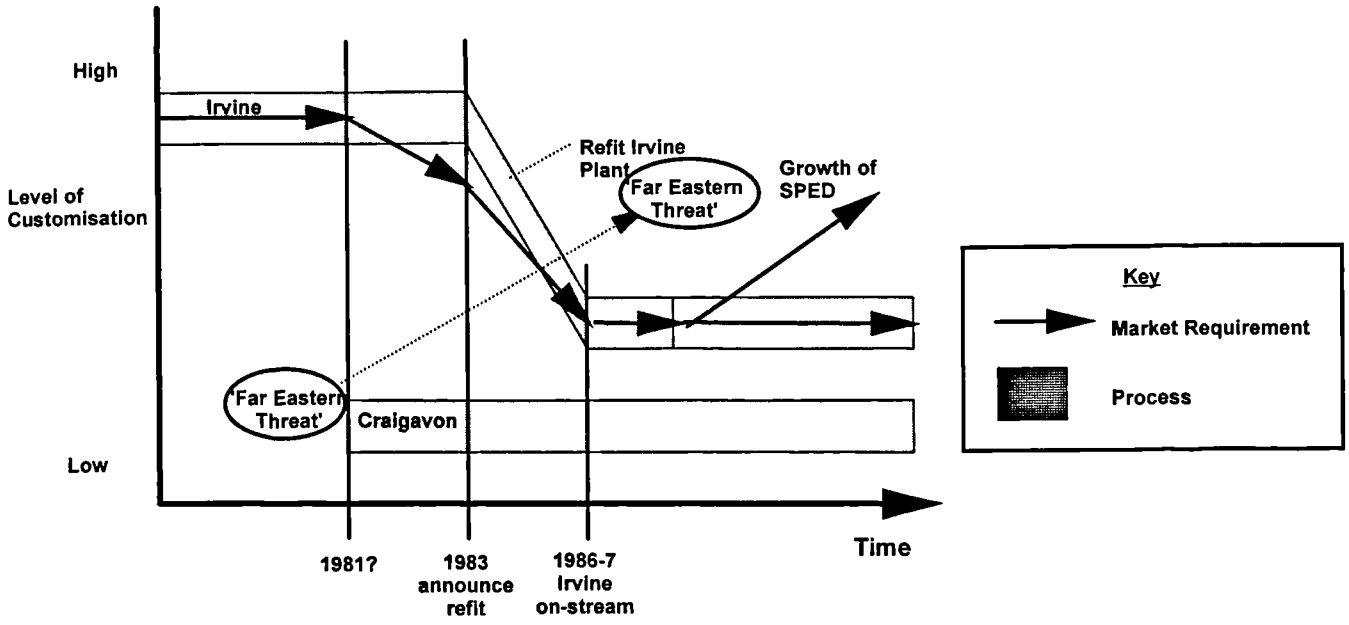
9.5.1 Hyster-Yale

Hyster's past contains a number of indications as to the underlying forces that contribute to their present position. The market was contracting during the period leading up to the research and there had been a significant competitive threat from the Far East. The major strategic move that Hyster made in the last fifteen years was to tackle head-on this Far Eastern competition for 'high-quality, low cost product with limited option features' via the XL product-line and the opening of a new purpose-built plant at Craigavon in the very early 1980's. This plant did and still does produce a low variety of small, high-volume products. This was evidently successful, so 'the company' decided to adopt the same approach 'across all product ranges and all locations', including Irvine. The major re-equipping of the plant was undertaken and production started only six years before the present research began. Increasingly heavy customisation has been apparent for three or four years and, as such, it appears to have been a significant factor from the outset, or very close to it.

The XL product was a significant departure from character. Prior to that, all products had essentially been custom-designed, and the nostalgia among the applications engineers for the days when 'we used to do anything' runs deep. Prior to the refit, Irvine manufactured much larger trucks as well as the medium-weight ones it was to produce afterwards. Thus it was accustomed to a wider variety of products in lower volumes. Craigavon had been a greenfield site but Irvine wasn't. The strategy that had been a success at Craigavon was translated to Irvine, where the culture of customisation was well established, to serve a market to which very basic XL design

seems less suited without customisation and, arguably, several years too late.

This strategic shift is shown schematically in Figure 9.1a, which shows the level of customisation over time, both of the market's requirements and Hyster's provision for it in its manufacturing operations. Also indicated is the so-called 'Far Eastern Threat'.



(a)

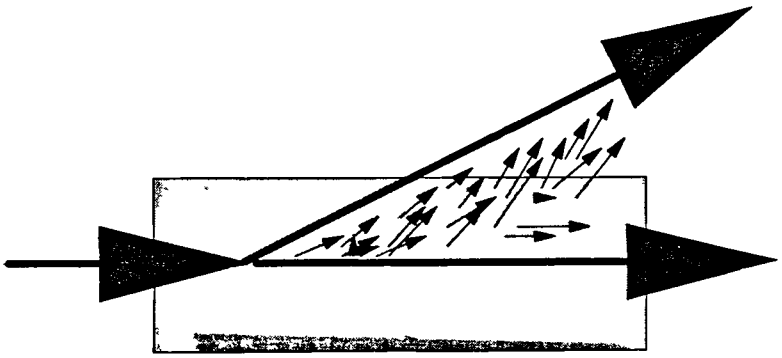


Figure 9.1 Tracking Hyster's Manufacturing Strategy: Deliberate Strategy, Cumulative Strategic Drift and the Heavy Hand of the Past

The drift or divergence of the business toward more and more SPED work (to strategically significant proportions) was the cumulative result of many decisions to accept custom-designed work, constrained only by the law and the capacity of the (rather heavily-staffed) SPED Design Engineering group. Figure 9.1b attempts to represent the cumulative effect of these decisions in the way that Mintzberg and Waters (1985) show emergent strategy. Although there is a sense in Mintzberg's diagram of a strategy 'heading towards' some conceptual target, no indication is given as to what the axes of the diagram are. Presumably left to right is time (as it is in Figure 9.1 a and b), but the vertical dimension is not specified. Here, the dimension is specified, albeit with the somewhat problematic but adequate-for-now dimension of 'Amount of Customisation'. Mills et al (1994) have used something like this to show the interaction between strategy events at different levels in the hierarchy, but here the use of second dimension is entirely different - to show changes on some presumed-strategically-important dimension, adapting the basic concept of Johnson (1988) to the specific issues of manufacturing strategy. The key issue here is that there are not only present contingencies and the present environment to consider, but also the past. Furthermore, it appears to confirm the suggestion of Hayes and Wheelwright (1984: 31) that organisational issues are the ones that are most pervasive, most difficult to change and therefore *most* strategic. Refitting the plant is one thing; changing people is quite another.

9.5.2 Honeywell

Honeywell's AOM business is the most acute case among their main product-groups of old products facing a new competitive world, due particularly to the opening up of previously domestic markets to anyone in the world. Manufacturing for all the product-groups has been dis-integrated to allow concentration on 'core processes' i.e. various upstream stages such as die-casting were subcontracted. As noted, despite the different strategic positioning among the three main product-groups, the response in articulated manufacturing strategy has been the same for all three.

The Design Group had incrementally taken responsibility for heavier and heavier customisation. The elegant matrix structure in the organisation chart gives the wrong impression of a situation where, in reality, the design engineer still acted as project manager, applications engineer, cost accountant, buyer, expediter and arbiter of commercial wisdom, rather than as a 'resource' to be allocated when some drawing was needed.

The uncoupling of sales from manufacturing divisions via the sales 'affiliates' exposed the Newhouse operation to internal competition from their US division, with the tendency developing for European sales affiliates to go to the US plant for routine jobs and to come to Newhouse for their more exotic requirements. This, of course, was taking place at the very time when design capacity and expertise was being reduced, managerial support for AOM was moving from the UK to Europe, and the pressures for improvement of systems were growing.

Figure 9.2 shows, over time, one possible strategically relevant issue. As customers were requiring more continuity between design, procurement, manufacturing and testing, the firm lost its means of providing this, first by the backward dis-integration (without providing a satisfactory replacement via purchasing, judging by the case chronology in section 5.6.3) and subsequently by removing the informal mechanism (the Design draughtsman) without a satisfactory subsitute.

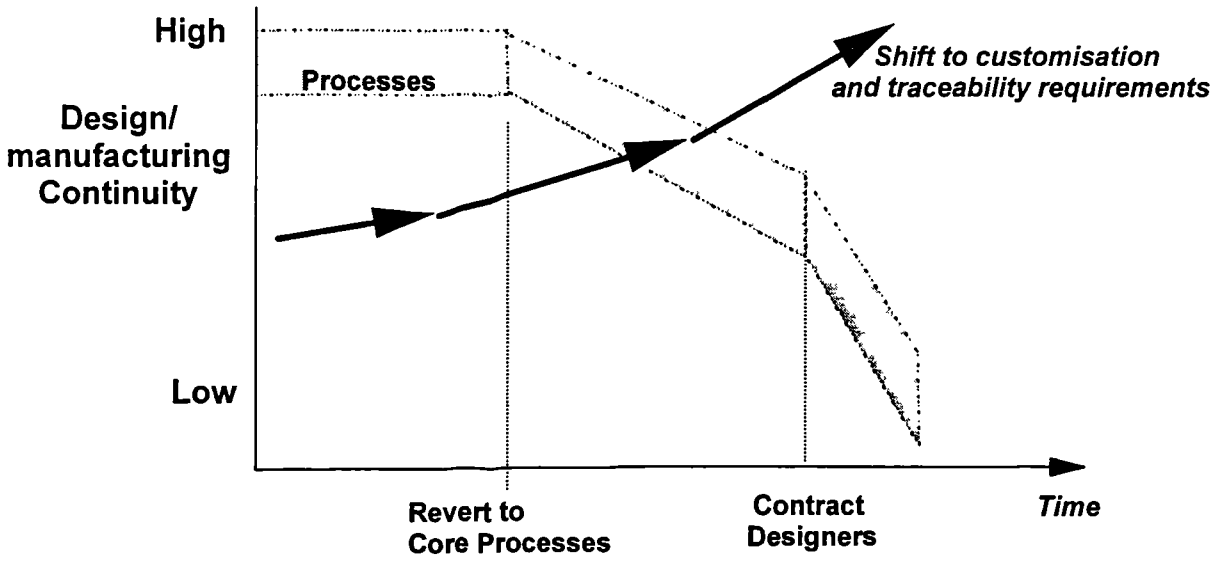


Figure 9.2 Tracking Strategy: Honeywell

9.5.3 Philips BCS

BCS underwent huge changes within the few years prior to and during the research. Operations from two separate factories were consolidated into one workshop, with a further range of products (digital terminals) brought in from the sister plant. Major and rapid changes in process and, in particular, product technologies were taking place, whilst at the same time the firm was moving into more and more international territories. The firm vertically dis-integrated, both backwards and forwards. One feature which links some of these issues together is the nature of relationship with the principal customer base. Historically, the firm had been used to dealing with BT in a close relationship that provided stability in product design and manufacture. BT required high performance products and were not overly price-conscious, particularly in systems (as opposed to phones). Sopho-S was probably designed with them in mind as a major customer, but this did not transpire. The product, and the supply chain that produced it, was then exposed to much wider internationalisation that it proved capable of supporting and to much more price-based competition in the dealer channel that came to generate the bulk of sales. As the market shifted to price, Philips BCS tried to make the product better able to compete on cost, whilst at the same time trying to upgrade it for more demanding international territories. At the time of the research, it was facing the prospect of a return to significant trading with BT for this product i.e. moving back to a selling situation with relationship characteristics (Håkansson, 1982: 17). Again, taking this as one of a number of potential strategically-significant issues, this can be tracked as per Figure 9.3.

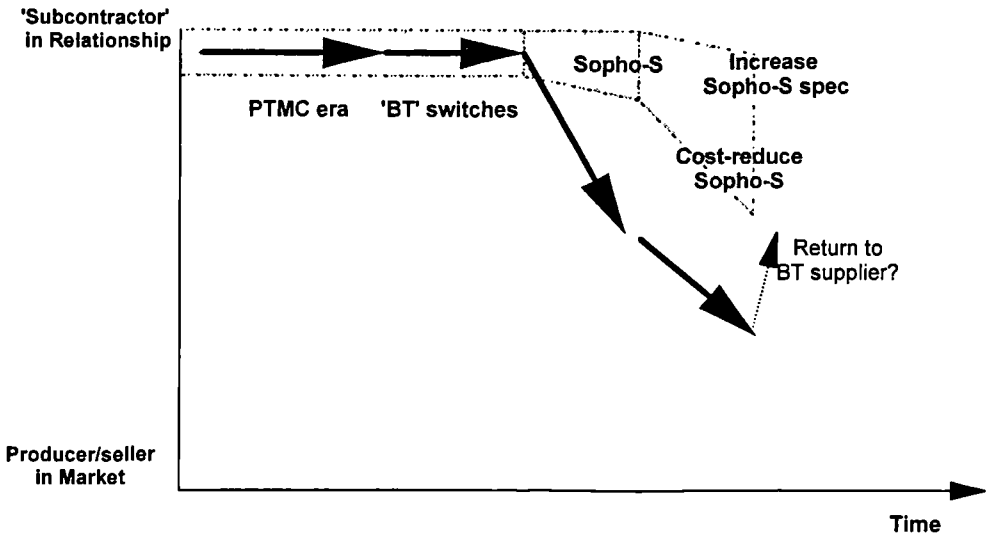


Figure 9.3 Tracking Strategy: Philips BCS

9.5.4 Letts

Letts appeared to have rewarded their sale force for selling volume - of anything. The most notable strategic shift was the adoption of OPT principles and the focus on making profitable orders only. Arguably, this also involves a move towards the market end of the markets-hierarchies spectrum (Thorelli, 1987) as orders are assessed

solely on their ability to generate profit in the current year. The intimations of stronger relationships being developed with some customers may indicate that, in the not-too-distant future, this approach will have limited potential for long-term success. This is shown in Figure 9.4

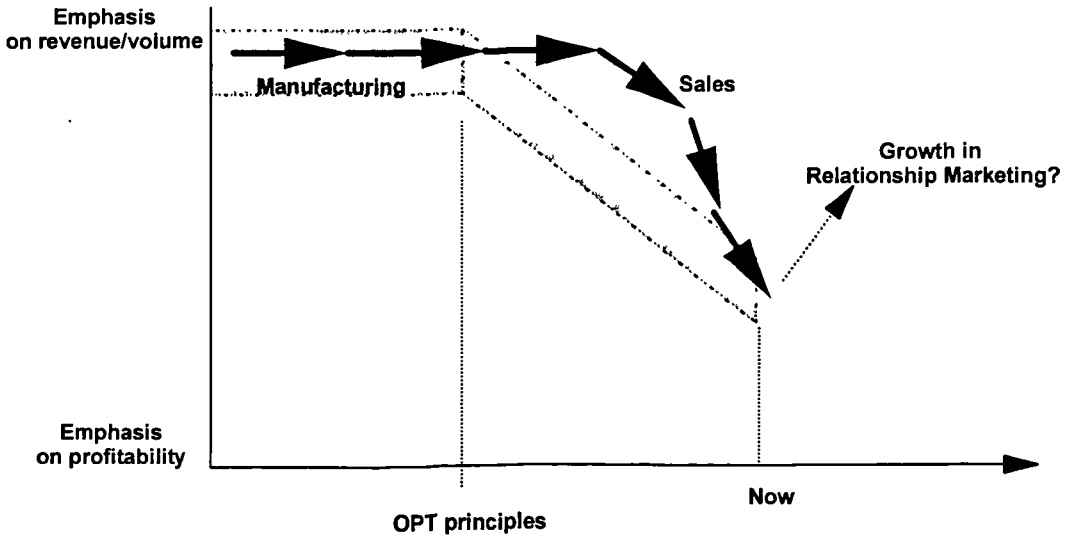


Figure 9.4 Tracking Strategy: Letts

9.5.5 Cross-Case Analysis of Influences

This perspective helps further to identify a number of potential bases for generalisation outside the cases. Some of these confirm the issues that were proposed as potentially important during research design, and which consequently shaped the choice of cases. Others are additional to these. Four cases have been adequate to identify the following factors that appear to be significant influences on strategy, often becoming evident as the culture of the company or plant, rather akin to the 'character' that predominated Selznick's concept of distinctive competence (Selznick, 1957: 53-54)

Changing market structure and composition: New entrants with possibly different approaches arise due to newly-emerging economies or deregulation-induced opening up of markets (Hyster, Honeywell, Philips).

Firms with long-standing technological base: Possibility of neglecting business basis of decision-making in favour of technology momentum (arguably all the firms).

Industry-specific Contingencies: Aerospace, automotive and other safety-critical industries increasingly require 'full service' as well as tangible products - guarantees of traceability, quality assurance, timely involvement in design projects (particularly OEMs), appropriate and customised logistical and administrative arrangements.

Products based on rapidly-changing technology: Potential for implicit if not explicit

dominance of strategy process by those in control of product development and technology (notably Philips BCS).

Concentrated Markets: All the firms face change here, and all face difficulties or potential difficulties as a result. Not all the firms are facing growing concentration e.g. Honeywell retain few customers, but potentially more with greater geographical scope and move into new customer segments e.g. automotive. Most are moving toward key accounts in some segments.

Level of access to end customers: Distribution intermediaries affect visibility of customer needs (Hyster's dealers, Philips' dealers).

Although other factors could be identified, the contention is that these factors are among the most important influences on the emergent strategy process. Customisation is particularly susceptible to many of these, by definition in some instances, and acts both as a revealing extreme case for manufacturing strategy issues in general, and as an issue in its own right.

9.6 Focusing Service and Manufacturing Strategies: Transaction Costs

The analysis of section 8.12 discusses a re-conceptualisation of customised manufacturing as a service process. The cornerstone of manufacturing strategy theory is the trade-off. If a widely generalisable theory of *operations* strategy is to be developed, then it will be necessary to move beyond the manufacturing-specific concept of the trade-off.

The starting-point for this is the work of Tinnalä and Vepsäläinen (1995). They relate the type of service to the type of channel, based on transaction cost analysis, using a framework isomorphous with the product-process matrix of Hayes and Wheelwright (1979a). According to Tinnalä and Vepsäläinen, there exist efficient or generic service processes that are analogous to Hayes and Wheelwright's 'on-diagonal' manufacturing process types. The compromise that is struck in manufacturing is between set-up costs and process dedication; in services the compromise is between 'production' i.e. service delivery costs, and transaction costs. For example, for their custom-built products, Hyster have eliminated many transaction costs by shortening the channel: the dealer inputs information to the computer system which automatically procures material and plans production without another agent in the channel. However, their problem-definition process is dedicated to defining a particular class of materials handling problem according to a very limited and entirely pre-determined set of parameters.

Tinnalä and Vepsäläinen's framework (see Figure 9.5) has four types of service and

four types of channel structure. Broadly speaking, the more intensive, customised and complex the service, the longer the channel used to provide it. To carry on with the Hyster example, heavily customised products involve applications engineers, sales support staff and, possibly design engineers in a front-office role, to carry out the problem-definition service. Philips BCS have moved away from internal hierarchies through vertical dis-integration, but have a more complex problem-definition task than they anticipated; Honeywell's move away from an internal hierarchy (sales 'affiliates') does not provide the close working relationship that the plant would like to manage its back-office activities.

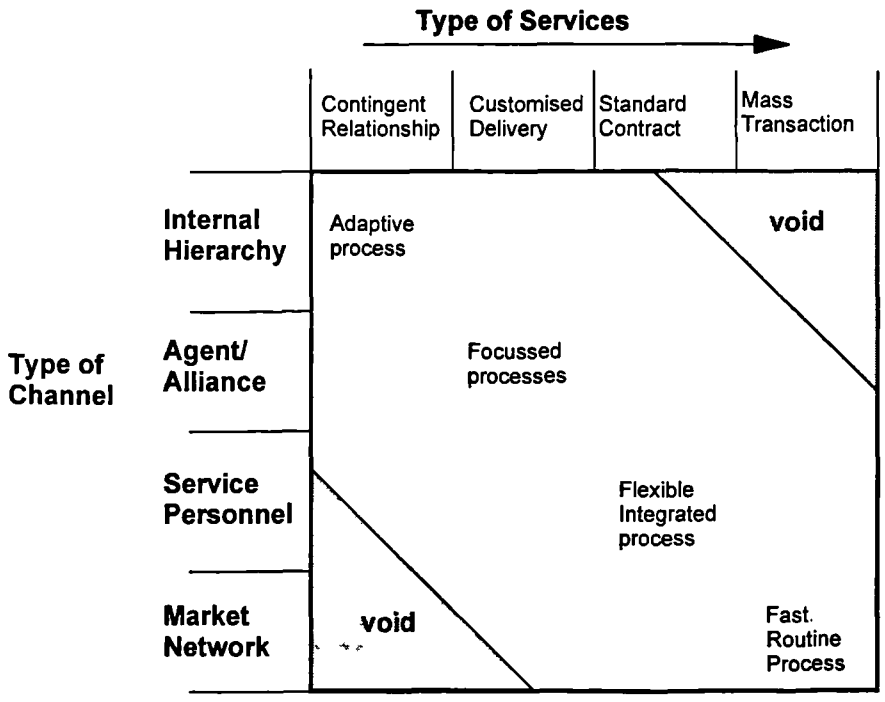


Figure 9.5 Service Process Analysis Matrix (source: Tinnalä and Vepsäläinen, 1995)

The categories and definitions used by Tinnalä and Vepsäläinen are occasionally unclear and inconsistent, but the underlying identification of transaction costs versus production costs is very powerful. It appears to provide a way of linking the service elements to the production elements in an operations strategy and to enable the incorporation of the channel structure insights from section 8.11 into an overall theoretical framework. Thus an overall operations strategy can accommodate the traditional volume variety concerns in the back-office elements and the transaction cost issues in the problem-definition (front-office) stage. The key issue appears to be how well structured the problem is. Although further work would be needed to develop the link, the matrices could be linked to the general model as indicated in Figure 9.6.

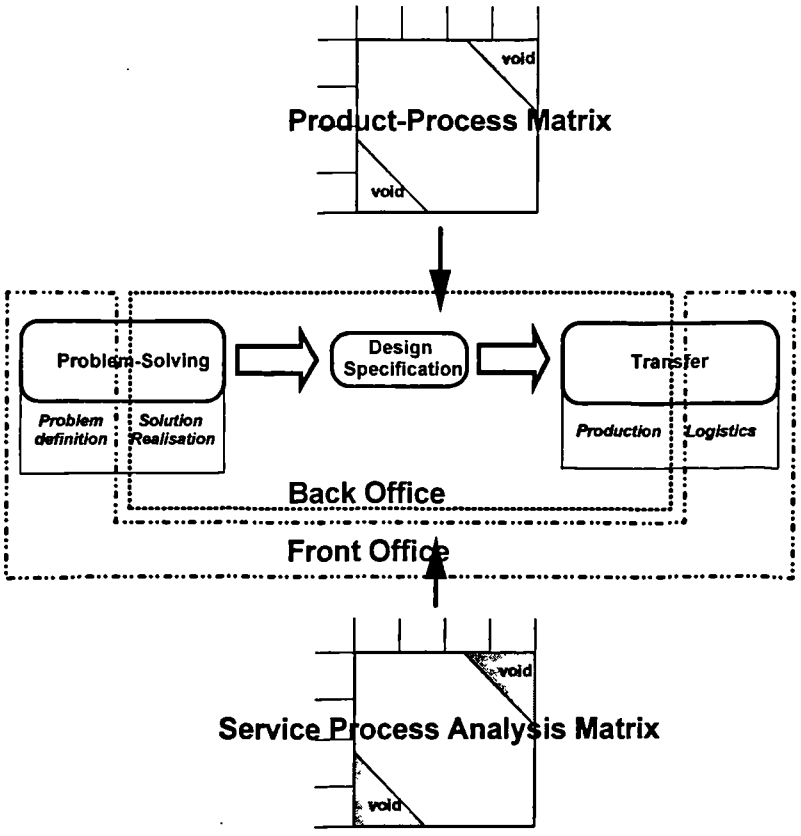


Figure 9.6 Assessing Service/Product Consistency

This would provide a basis for assessing consistency not only within the traditional bounds of the manufacturing process, but also *between* the manufacturing and service elements.

The emphasis of Tinnalä and Vepsäläinen on channel structure also offers an opportunity for operations strategy to embrace aspects of supply-chain management theory more convincingly than hitherto.

9.7 Manufacturing Strategy and Industrial Markets

It is evident that there are a number of limitations in viewing all plants as 'winning orders' in perfect markets. Particularly in industrial markets, the relationships that exist lie somewhere between internal hierarchies and perfect markets (Thorelli, 1986) and are characterised by long-term, mutually-beneficial behaviour. Product customisation is a very good example of this type of behaviour.

Although some approaches to accommodating this have been discussed - e.g. evaluating manufacturing priorities based on customer portfolios rather than, or as well as, product/market analysis - the principle could be taken a lot further. Two concepts appear to be useful.

Hayes and Wheelwright (1979a) have suggested that manufacturing strategy is related to the stage in the product life cycle. This is, clearly, a view centred on

product/market analysis. For a firm such as Honeywell, the portfolio of a relatively small number of customers is of paramount importance to its success. As such, it appears useful to relate manufacturing strategy - or, more accurately, operations strategy - to the stage of relationship development. A plant attempting to supply to customers about whom it knows very little cannot commit resources in the same way as a plant that is supplying a small number of customers with whom it has long-standing collaborative relationships. Ford (1980) has identified five stages in buyer-supplier relationships; moving through these involves reductions in uncertainty, of various forms of 'distance', and mutual adaptation. It is clearly not just the marketing personnel that adapt: operations may invest in customer-specific design activities, process equipment and administrative routines, for example. Reduction in uncertainty will involve a need for less, or different types, of flexibility. It is suggested that the operations issues relevant at each stage may be as indicated in Table 9.1.

Of course, not all industrial markets are like this: some are very much closer to pure markets. Blois (1980) identified market concentration as a fundamentally important issue. This too can be elaborated. Van Weele (1994:67) presents a typology of market structures for the development of purchasing policy (Figure 9.7). It does not seem far-fetched to suppose that operations strategy should be influenced by these same issues. Firms like Hyster and Letts, who are one of a few suppliers with many customers, are unlikely to make customer-specific investments. They need to retain certain types of flexibility - product flexibility perhaps. On the other hand, firms such as Honeywell may well invest in assembly and test equipment suited to one customer or a very small number of customers in a specialised niche market.

Table 9.1 Manufacturing Strategy and Relationship Maturity

(developed from Ford, 1980)

Stage	Relationship Characteristics	Operations Issues
Pre-relationship	Evaluation of new potential supplier	Technical ability to quickly evaluate suitability of business. Sales-Design-manufacturing integration. Service rich
Early	Negotiation of sample delivery	Opportunity to influence design to suit manufacturing strengths. Cost not an issue.
Development	Contract signed or delivery build-up	Formalisation and ability to translate design/prototype quickly to scale-up.
Long-term	Several purchases/ deliveries	Transfer cycle dominates - capacity management and customer-specific technology
Final	In long-established, stable markets	Major customer-specific investments and procedures. Refinement of logistics

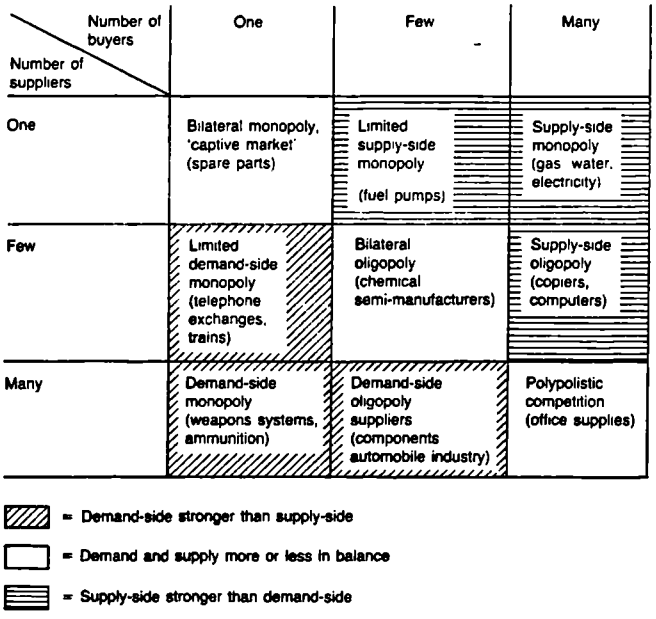


Figure 9.7 A Typology of Market Structures (source: van Weele, 1994: 67)

9.8 Manufacturing Strategy and Core Competences

Many aspects of the foregoing discussion indicate that manufacturing strategy is about much more than aligning process and infrastructure with a selected competitive criterion. Changes in volume-variety with the stages of the product life-cycle, and the necessary changes in process and infrastructure that went with them, may once have taken place over time-periods that could be described as strategic. Increasingly, as product life-cycles shorten, providing the right competitive emphasis in products/markets becomes tactical. The strategic issue in this context is the very ability to change between criteria.

The core competence literature emphasises technology acquisition (e.g. Prahalad and Hamel, 1990), but there are many more specifically operations issues that are just as pervasive and enduring. Examples include the ability to introduce new products and manage variant succession, or the ability to track relevant performance objectives, even though what the objectives are may change.

9.9 The Future of Customisation

All the evidence indicates that customised products will become increasingly commonplace (Pine, 1993). Although there is considerable excitement about mass customisation, the more prosaic but no less important process of custom-design within close relationships, particularly between OEMs and their suppliers, is increasingly

relevant. The requirement will exist, then, for a better and more sophisticated understanding of product/service customisation. The role of information systems is likely to be of paramount importance, be they computer-based, person-based or, more likely, a combination of the two.

9.10 Suggestions for Further Work

The work reported here identifies a number of opportunities for further work. These are outlined below.

9.10.1 Testing and Refining the General Model

The first priority would be to test out and develop the general model. Although the model captures many of the issues in the cases, areas that may need particular attention are:

- other categories of customisation that may be relevant
- the influence of customer expectations of transfer during the problem-solving stage
- a more effective incorporation of individual product transfer cycles into a

model of the manufacturing system's activities involving all products.

This would best be carried out by further case-studies, of a more focused nature, in various industries, including consumer and 'pure' service industries. Small firms, and firms explicitly operating solely as custom-designers, would also offer another point of comparison and theory development.

9.10.2 The Service Aspects of Manufacturing

The argument was developed that customisation involves a large service operation element. It would be very fruitful, it is contended, to study the applications engineering, design engineering and other manufacturing-related activities of more firms as a part of an extended service operation. The first and most fundamental issue would be to examine how firms could design and define the service aspects more explicitly and their operations accordingly. This could best be carried out by using an action-research approach. Other elements of such a research project would include:

- a continuation of the study of design engineering and manufacturing as an integrated 'back office' activity;

- an examination of the logistics service in the transfer stage, an aspect neglected by the cases reported here;

- ways to exchange product customisation for service customisation;

- development of the potential of Tinnalä and Vepsäläinen's transaction cost based matrix of service type and channel design.

9.10.3 The Marketing-Manufacturing Interface

As we have seen, there is some doubt about the 'interface' as a useful construct. One theoretical tool that could help this rather stale debate along is to examine the possibility of an 'Operations Concept'. If there exists a 'Marketing Concept' (and there is considerable debate about this (Brown, 1995: 41-46)), then why is there not a similarly widely-expounded and carefully-debated Operations Concept? At a time when the boundaries of the operations function are being stretched and changed, it would be very valuable to examine fundamentally what operations is and, by implication, whether it can in principle be squared with the marketing concept.

9.10.4 Boundary-Spanning Roles

The work has identified the importance of particular types of staff in facilitating the linkages between stages of the customisation process. Applications engineers are a neglected area of study; product managers are more widely recognised in the marketing literature, but the activities and tensions exposed by the present research

indicate that much remains to be said about their importance and potential. A detailed study and taxonomy of both these roles would be revealing, particularly if conducted from a service operations standpoint rather than the more conventional marketing one.

9.10.5 Operations Strategy in Industrial Markets

The present work has gone some considerable way in arguing that a different approach is necessary to theorising manufacturing strategy in the type of relationships typical of industrial markets. There is an urgent need to develop this work along the lines suggested i.e. using relationship characteristics and market structure as contingency variables in the way that product life-cycle stage has been used in the past.

It appears likely that particular operations approaches are adopted by firms developing close relationships with a small number of customers, and such issues as the extent to which investments in process and infrastructure are customer-specific are important areas for study. The analysis of customer portfolios rather than products/markets has been proposed as more appropriate to such situations: this must be examined further in an action-research study.

9.10.6 Operations Strategy and Core Competences

The incorporation of the core competence view is arguably the most important challenge to operations strategy theorists for the next five years. As shown in various ways here, the focus exclusively on products and markets that typifies manufacturing strategy literature misses a number of important areas of concern. The linkages between problem-solving and transfer cycles are just the kind of abiding competence that this more recent literature emphasises as being the locus of long-term competition.

To chart out a research programme to address this would be an enormous undertaking in itself. The present work though, could be the starting point for focused attempts to identify what generalisable core competences exist. Is ability to customise a core competence? Does the 'heavy hand of the past' that so influenced the strategic directions of the firms also imply a strong hand for the future i.e. a difficult-to-emulate competence?

9.10.7 Emergent Strategy Processes

This is linked to the previous item. The strategy tracking technique has indicated that identifying strategies emerging from cumulative 'little' decisions can reveal profound forces at work. Although some attempt has been made to acknowledge that in the strategy prescriptions, the approach is still essentially top-down.

The tracking technique could be developed in action-research studies. Either through this or through other means, a study of emergent strategies in operations is long overdue. By definition, this would be longitudinal and intensive, perhaps taking as its starting point the kind of analysis of the differences between explicit and implicit manufacturing strategies used here. Another aspect worth developing is the apparent attraction to managers of 'concrete' strategic initiatives such as product-based programmes or 'reducing the size of the business'. If, in the end, it is through such programmes that strategic change is actually effected, then operations strategy may need to take account of this by articulating its concerns in less abstract terms. One way to do this might be to re-examine the potential of new product introduction as a vehicle for implementing more widespread changes in, for example, quality standards, core technologies or work organisation. In this way the operations function could be seen as using new products proactively to build competences, rather than merely reacting to 'market requirements'. An action-research study may be also be appropriate here.

9.10.8 Operations and Geography

Operations management only treats spatial aspects in a very crude and quantitative way in location theory. The work here indicates that the micro-location of operations and operations-related personnel has an important bearing on the effectiveness with which they carry out their functions. The importance of face-to-face communication and the linkage between what have been termed here front-office and back-office

activities seem closely connected to the question of where people work. This has been addressed by industrial sociologists but, bearing in mind the apparent importance of information transfer in the customisation process, should be more than a curiosity to operations management researchers.

The preferred way of examining this would be by a longitudinal ethnographic study, perhaps using the general model developed above as a framework to identify stages and overall activities. The important issue would be to separate the spatial effects from those related to functional affiliation, background and other potential factors. Operations managers would have a particular interest in which stages of the process should be carried out by face-to-face communication, and which by remote methods.

9.10.9 Mass Customisation

The evidence here suggests that the much-vaunted concept of mass customisation can only ever answer a fraction of industry's needs. Most of the research on mass customisation is very uncritical. It is time then, that the concept be subjected to critical scrutiny to establish whether it is the next big thing, or merely a localised answer to a localised problem. Mass customisation excludes genuine custom-design. Is the need for this merely a failure of designers to be smart enough to modularise their product designs, or can modularisation only ever answer a fraction of our needs? Mass customisation assumes that customers appear out of the blue, specify their product and require it quickly. Isn't this exactly the opposite of the situation where

industrial customers develop long-term relationships with their suppliers and never appear 'out of the blue'; i.e. is the mass customisation concept a figment of the imagination of academics obsessed with the idea of atomistic, discrete purchases occurring in a 'pure' market? And just how much mass customisation goes on anyway?

9.10.10 The Trade-Off

Perhaps fittingly, the last word is on the Big Idea. Attempts to apply the trade-off here indicate that, despite its maturity, the concept is still fairly poorly understood. The literature has been preoccupied with proving or disproving a 'general law': it appears more fruitful to examine specific, concrete embodiments of particular trade-offs and to try to change them. Only by this approach can headway be made in understanding the nature of the trade-off concept more generally. Also, the general model has radically altered the relationship between the competitive criteria, showing some to be the outcome of problem-solving, and others of transfer. If this is the case, then it is misguided to treat them all as outcomes of the same process. A programme of research to examine the trade-offs within and between the stages offers another way forward.

Appendix 1

Data-Collection Instrument

1. Plant Synopsis

1.1 Organisation

Which organisation owns the plant?

How many plants do they own in total and what are their respective roles?

What are the major events in recent plant history and, where relevant, company history?

What is the organisation structure within the plant and with immediate corporate contacts e.g. corporate or group marketing function? Obtain an organisation chart.

How many employees: in production & related functions? in other functions?

1.2 Products

What are the main products supplied? Categorise as capital, intermediate or consumer.

In simple terms, how many different products are offered ?

What are the key *product* technologies?

1.3 Markets and Customers

Who are the main customers? - What type of organisation or individual? Where?

What are their respective concerns?

1.4 Production Processes

What is manufactured and what bought-in?

What are the principal *production* technologies?

What are the principal *embodiments* of these technologies, how old are they and how are they organised?

What is the policy on make-to-order vs make-to-stock?

1.5 Financial

What is plant turnover?

Cost breakdown? - direct/indirect, labour/material/ overhead

What method is used to allocate overheads?

2. Manufacturing: The Design Cycle

2.1 Organisation

How are customers' requirements communicated to the plant? What are the roles of field sales, on-site applications people, etc.?

Is sales/marketing decision-making integrated with manufacturing? Itemise links: formal, structural (i.e. built into organisation structure); formal, non-structural e.g. committees, cross-functional teams; informal e.g. physical proximity.

2.2 Technology & Innovation

What organisational provision is there for product R&D? Is there a Director?

What is the relative maturity of the key product technologies?

Is there a plan for product technology and NPD?

What is the time-to-market for new products?

How many distinct NPD's in the last 5 years?

How many planned in the next 5 years?

2.3 Products

How diverse is the product range?

* How many product lines?
* Average number of products per line?
* Total number of products

How mature are the product lines?

* Product Life Cycle length and stage

How "standard" are the products, according to sales documentation? Give proportion that are:

Standardised products
(a) with no options
(b) with standard options
(c) with customer-specified options
(d) modified to customer specification

or Customised product produced to customer specification.

How stable are the product lines? How many new products or modifications to existing products (as opposed to extra variants)?

What are the competitive criteria for each product family?

3. Manufacturing: The Material Cycle

3.1 Process Input

How many "live" items in plant at a time?

How many parts and subassemblies are produced?

How many bought-in components?

What are respective volumes of product families and how lumpy is demand? Look at demand over at least a year.

Make-to-order vs make-to-stock volumes?

Required leadtimes?

3.2 Process Technology

Are key process technologies (not embodiments) proprietary or industry standard? State-of-the-art or not?

What is relative maturity of key process technologies?

Is there an explicit role for process R&D?

3.3 Production Facilities

Plant size and age?

Recent or imminent investments? How much, on what and when?

What are main process stages?

How are they organised? Categorise by job > batch > process.

What are the key parameters of each: setup, process times, etc.?

How are processes selected per product? And specified to operators?

What are the performance measures?

3.4 Production Output

What is profitable? for each product family:

slaes as % of total sales
contribution as % of total
market share ranking/ no of competitors
growth of market share
growth of market

For each product family (?)

actual performance w.r.t.:

Features
Quality
Delivery lead time
Delivery reliability
Material scrap
Labour production
Overhead %
Stock turnover

set-up and changeover times/ "flexibility"

4. Chronologies (where applicable)

4.1 Definition

Which aspect of the operation is to be investigated in depth?

Is it : a product line?
part of the design cycle?
part of the material cycle?
a particular customer, customer group or market?

Is the data from: a past, completed project?
a project currently in the material cycle?
a project currently in the design cycle?

4.2 Case Background

Describe how the current situation has arisen. Quantify and give dates where possible.

e.g. for product groups, describe introduction, give evolution of range including history of sales volume per variant, describe reason for current interest.

for sub-systems of design or material cycle, describe sub-system and its development, give key processes and parameters, describe problem areas as perceived by participants.

for customers, give quantitative data on sales history, order make-up, key competitive criteria, reason for current interest.

Use similar approach for other types of investigation.

4.3 Role of "Standards"/"Specials"/"Competence"

To what extent does the sub-set involve "non-standard" work?

How, *in practice*, is "non-standard" defined?

What are the perceptions of various participants of what is or isn't "standard"? Customers (via sales catalogues etc); field salespeople; marketing management; technical sales or equivalent; manufacturing senior management; shop floor management; doers.

4.4 "Special" Products in Practice

What are the activities driven by *nominally* "non-standard" products? Itemise within design-cycle (enquiry/ applications/quote procedure etc.) and material-cycle (tooling, process design, machine loading, training) groups.

What have been the implications of the "special" features required for the manufacturing technology and process?

How are "special" products costed? Obtain actual examples and identify, where appropriate, the "standard" product on which costing is based and criteria for similarity.

Where possible, identify actual processes used and their congruence with those used as costing basis. Concentrate on differences due to technical reasons rather than expedient re-scheduling.

How has delivery time/reliability been on these products? Can delivery performance be compared for "specials" and "standards" overall?

How have cost variances been?

4.4 Actual "Standard" Activity

What are the activities driven by each new "standard" product?

What process "blindspots" exist in practice? Identify extremes of each manufacturing technology and process. Talk to shopfloor people, engineers, review quality/cost data.

Are there "standard" processes that are, in practice, "special" - needing disproportionate skill or exhibiting jobbing characteristics within batch process.

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