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The need for product lead strategies in manufacturing industry.

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THE NEED FOR PRODUCT LEAD STRATEGIES IN MANUFACTURING INDUSTRY

Submitted by Peter J. Metcalfe for the degree of M.Phil of the University of Bath, 1985.

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Peter J. Metcalfe.

September 1985.

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This research project has only been made possible by the tremendous support received from many individuals, business enterprises and members of staff at the University of Bath or other educational establishments. To all of them including the engineers, designers, craftsmen, directors and innovative machinists, I would like to express my sincere thanks for the willing assistance, patience and valuable time. The opportunity to be a fly on the wall at meetings and activities related to the development of product ideas has been a great privilege. Listening, watching and learning how an idea becomes a reality has been an absorbing experience, which I believe will remain with me for the rest of my working life. Observing the natural wish of so many individuals to participate in and enjoy the creative process has also been sobering, and I can only hope my interpretation of the data received reflects the spirit in which it was so generously given. If for any reason the views expressed cause offence to their authors, I can but only offer my sincere regrets.

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Peter J Metcalfe
September 1985.

SUMMARY

The role of product design in manufacturing industry, the latter defined as the business of making things continues to elude acceptance on recognizable terms. Design tends to be perceived as either the addition of an aesthetic quality to achieve consumer appeal or the nuts and bolts of production based upon practical application.

Attempts to clarify the dichotomy may have, however, contributed to the notion that design is an appendage to the main purpose of the business and outside the normal criteria for managing success. Further, the invention of Design Management, peculiarly acceptable to U.K. and U.S.A. business, may have actually encouraged separation from other disciplines, particularly production. In addition, it has been proposed responsibility for the poor communication record of designers with non-design executives lies more with the design profession, as the lack of interest in the 1950's for marketing and computer expertise has not prevented these groups from gaining access to influence the decision making process. The difficulty possibly resides more in an assumption that if industry used designers more effectively, an improved trading performance would result. The regular failure of such a simplistic formula causes not only disappointment for those persuaded to try it, but also deflects attention from the real issue, which is the absence of lateral relationships at the design and production interface.

The foundation of Japanese post-war success rests upon the attention given to the quality of sub-system interaction within the manufacturing matrix. The journey from the designer's drawing board to the market is long, demanding a concern for detail at every point of the manufacturing activity. A product is only as good as the quality of the individual parts and if commitment is lacking, the product's performance will be defective.

The neglect of the design and production interface has become a major weakness and it is here that the principal need for the development of new attitudes is required.

Chapter I

Background

Background

The years 1977 to 1980 could well become viewed as a vintage period by historians, either as a turning point in the fortunes of British manufacturing capability or a further twist in the spiral of in-action and decline. The three year span witnessed the publication of a number of important documents, all of which have focused upon the inability of British manufacturing industry to match the performance being achieved by other industrially advanced nations, particularly the Federal Republic of Germany and Japan. From 1980, trade in finished manufactures has deteriorated to a point where 1983 saw the country record its first nett deficit since the industrial revolution. By 1984 the deficit had reached a record £3.6 billion. What is even more worrying, over the ten year period 1974 - 1984 manufactured imports rose by 456 percent, while exports during the same time-span only registered a 265 percent growth. For a country that inaugurated the industrial revolution, and to those of us who believe no nation can live without an effective making capability, these results are nothing short than calamitous.

The continuing and ever increasing tide of critical material is demonstrating a depth of unparalleled concern by Government agencies, NEDO, and its working parties,ACARD and the Cabinet Office, the CBI, TUC, plus professional bodies or informed individuals. Two Reports, 'Product Design' by Corfield (13) and 'Engineering our Future' a Committee of Enquiry chaired by Finniston (20) published in 1979/80 show clearly the seriousness of the situation facing any government who wishes to evolve policies to reverse the depressing performance of our manufacturing industry. Further, not only are we failing to design and make the right products at the right price, but other 'non-price' factors such as performance, reliability, technological change and transfer, poor quality components, the use of obsolete processes and delivery are also seen to be compounding a problem that has become a running sore. The gravity is again emphasized by the unanimity of the findings in both reports on a number of key issues, specifically:

- The lack of appreciation by manufacturing industry of the primary need to supply products which are relevant to the international market place.
- The U.K.'s declining share of world markets.
- British managements acute difficulty in comprehending the role of innovation within manufacturing, either as products, processes or management control.
- The inability of specialists to view management as a creative function, preferring to ignore those aspects of the business which do not fall into their sphere of interest.
- The failure of designers, engineers and staff engaged in production to identify with each other's disciplines.
- The low esteem accorded to manufacturing by British society has resulted in minimal Boardroom representation, a situation which is in stark contrast to other EEC countries, the U.S.A. and Japan.

- Investment is too often conceived as a nuts and bolts operation. Product innovation is rarely considered as a part of investment, despite the known correlation it has for securing the future livelihood of the firm.

Another facet is the unspoken tradition for the English educational system to polarize the Arts and Sciences, a factor brought into striking focus by C.P. Snow in 1959 with the famous 'two cultures' Cambridge lecture. At the time, the argument was chiefly directed at the way the Arts dominated and permeated the thinking of British society to the detriment of the Sciences, and as a consequence, the lack of access afforded to those with a Science background to the top echelons of government, the institutions and industry. Since then, the discussion has been expanded by Lewin (29) and others, who contend that this twin cultural tradition has left no room and indeed prevented, the acquisition of a third avenue of learning found in many European countries, and referred to in Germany as 'Tecknik'. The term has no equivalent in the English language, though translations abound, but in essence it encompasses the areas of knowledge and relevant skills that are related to the making of things within a manufacturing environment. Some commentators believe the absence of such a third cultural tradition has seriously hampered the development of the U.K. manufacturing sector, to a point where it has now become an economic liability.

Many of these recounted weaknesses are given further credence by an Anglo-German comparative study 'Growth, Innovation and Employment', in which Cox (14) examines the financial performance and allocation of resources within four industries, Mechanical Engineering, Motor Vehicles, Chemicals and Textiles. A number of pointers emerge from this imaginative and thorough investigation, the most relevant to this discussion being:

- A viable manufacturing company should not spend more than 70 percent of the value of its sales on materials and employment for current output. A successful business will spend less than 70 percent.
- Disposable funds available for innovative and technical investment should be in the region of 15 to 18 percent.
- Emphasis needs to be placed on increasing the margin of valued added to materials. This is particularly important for advanced economies who operate in a highly competitive environment.

The general drift of these findings is reiterated by a National Institute review completed towards the end of 1984 and reported upon by Elgin (18) in the Sunday Times. It makes depressing reading. A comparable analysis was conducted of British and West German engineering firms who were making relatively ordinary products such as screws, drill bits, valves, etc., with similar technical resources and manning levels. From the British side, the review cited a catalogue of problems including complacency, management inertia, inadequate organization and a shortage of skilled staff, which between them enabled the Germans to achieve levels of efficiency that were on average 63 percent higher than the British in real terms. As Elgin comments:

> 'From management down to the shop floor, the Germans had higher qualifications. In 14 of the 16 British firms visited, the production foremen had none. All 16 of their German peers had passed exams as craftsmen, 13 had reached the level of master craftsman and the other three were on courses to reach this. The more skills workers acquired, the more they earned. British foremen said they couldn't convince managers to invest in new machines or better equipment: too often, they were salesmen without technical background, suspicious that equipment manufacturers were trying to pull a fast one.'

Cox also confirms in her earlier study a similar bewilderment by stating '.......when two parallel sets of data for the same industry are examined side by side, on identical sets of worksheets, new insights are obtained. Why should the West German and U.K. industries prove so similar in some important respects and so vastly different in others? Is the philosophical approach to industry in any way responsible?'

The philosophical thread is touched upon time and time again in the Finniston Report, tracing in considerable depth the place and performance of the British manufacturing sector within the economy and brutally suggests by the use of official statistics, that the national commitment to the difficult task of making things is anything but total. Attention is drawn to the public and to some extent educational establishments ignorance of what an engineer does, the low esteem the profession has amongst peer groups and the blinkered attitude engineers have of their role within society.

Why the contrast and what are the tangible influences running through our society that prevents the engendering of a holistic attitude by all those concerned with the organization of manufacturing? Finniston's phrase 'the engineering dimension' neatly encapsulates a concept, insisting the profession must recognize the interplay of engineering with other management functions, including finance, marketing, design, research, production and selling. Lorenz (30) reinforces this requirement by arguing the need for the product to become the central life-force of the organization and that unless it does, the chances of the business surviving are slim. This concept can best be illustrated by recourse to an incident recounted by Mant (33) , where Monty Platt of Platt Clothiers Ltd., sounds an alarm at 11.a.m. each day, the signal for those interested to move into the design office and examine the production quality of yesterday's overcoats. A random sample is available for evaluation by managers, juniors, production staff and designers who touch, put on and take off and generally discuss overcoats. The business's culture is the product and the daily ritual never allows that factor to be forgotten.

Lorenz also goes on to emphasize the importance of an innovative climate for success and draws upon research undertaken at the Massachusetts Institute of Technology in the U.S.A. and the Science Policy Research Unit of Sussex University into two multi-national companies, Philips and 3M (Minnesota Mining and Manufacturing).

They demonstrated two fundamental characteristics, that product innovation is promoted from the top down and once implementation policy is formulated, it needs to be led from the front. The method used by 3M involved the appointment of a relatively senior executive, who acted as the 'product champion', by taking responsibility right from inception through development to production and eventual marketing. Responsibility is accepted on the basis of permanent involvement until completion, permitting the appointee to select and establish a team possessing the requisite skills for worrying the project to completion. Experience has shown that such an approach can and does assist to negate sector boundaries and overcome inertia within the organization.

The analysis at this stage of the proceedings is over-simplified, though the material reviewed does indicate that if an advanced industrial economy is to sustain a viable manufacturing base, it needs to recognize the central position of the product. The attitude of the business, the organizational structure evolved to realize an effective response and the marketable quality of the product are, it is believed, inexorably linked into a single organic matrix. Ultimately, manufacturing's remit is to identify need, make and earn consumer satisfaction or as Ruskin remarked in 1860 'Your business as manufacturers is to form the market as much as to supply it'.

The essence of this research project is the examination of a critical junction point, namely design to production, which seems and based on experience to have received surprisingly little attention. The primary enquiry route has taken the form of a field study, the results of which are discussed and catalogued in Chapter II.

CHAPTER II

The Field Study

THE FIELD STUDY

Terms of Reference and Methodology

Introduction

From the outset it was decided to utilize the structured interview method as the major vehicle for conducting the field study, in spite of the known time cost penalty incurred by this approach.

It is known that communications between personnel engaged in design and manufacturing functions are inclined to be more complex than those experienced by other sectors concerned with product development. Up to now, other than the making of breadboard models or working prototypes, decisions taken have tended to be dominated by staff located in the marketing, sales and design disciplines. Implementation, however, puts a new and often unsettling element into the mix as theory, often supported by well tested principles confronts knowledge that has been learnt on the shop floor through a continuous process of custom and practice. Contact alters the complexion of the development team by taking on board two cultural traditions, which although not openly hostile are wary of each others intentions. To capture the available experience and distil into a view of the product cycle, it was felt a dialogue with the participants on a one to one basis offered the greatest scope for success. Alternative methods such as the more accurate Delphi sequential discussion with individuals by questionnaire or an interview/questionnaire combination were examined, but rejected on the grounds of being cumbersome and placing too much reliance on the conscientiousness of respondents to fill in yet another form.

Further, assuming the correctness of the questionnaire format, it was suspected that a face to face approach would in all probability enhance the quality of the information received and elicit other facets that can influence the progress and direction of the cycle. For here implementation is governed by the reconciliation of conflicting interests whose only common aim is completion, whether effective or otherwise. Such a scenario appeared to warrent the broader brush of the interview method, any accuracy lost being compensated for by the richer mix of the information gained.

In addition, a series of initiatives, sometimes taken independently and on occasion run in parallel, aided the programme of enquiry, particularly:

- Introduction to a number of prominent individuals with experience in the manufacturing sector by the University.

- Contacting of manufacturers with a view to examining the structure and organization adopted for the product cycle. (See Appendix WW).

- Attendance at two management seminars undertaken by one of the three finally selected companies, prior to the commencement of the product cycle enquiry.

This chapter is primarily concerned with summarizing the information learnt with regard to attitudes found in the staff engaged on the product development cycle and the degree of lateral communication achieved at the design and production interface.

The Companies

The selection was based on the premise that however sophisticated the product or the manufacturing process, common performance characteristics would emerge.

Accordingly, the research subjects were chosen because they represented distinctive levels of manufacturing capability linked to specific markets, described as:

- Low Technology - Fashion footwear.
- Medium Technology - Actuators for the control of pipeline valves.
- High Technology - Aerospace environmental control systems.

To provide a basis for a reasonable level of compatibility in the information received, the characteristics of the three selected companies were similar in so much that they:

- Supplied a range of products to meet specific markets.
- Possessed in-house manufacturing resources.
- Utilized sub-contractors.
- Employed design, development & pre-production staff.
- Had a systems approach to the management of the product development cycle.

Finally they were recognized to be leaders in the field of chosen activity and had a proven investment record in product design and development. It was therefore reasonable to assume they would be sympathetic to participation, which in the event was proven and in one case resulted in the presentation of the findings to the Divisional Board concerned.

Method

The enquiry was facilitated by three interdependent elements:

- A general review of the subject's historical background by reference to written material and discussion with principals responsible.
- A series of semi-structured, but open ended interviews with a number of directors and employees based in the key sectors; design development, pre-production planning and manufacture.
- An examination of the product cycle within the context of an ongoing product development programme.

Case Studies "A" and "B" followed a similar pattern by commencing with an introduction to the Chief Executive or Management senior staff. From these initial soundings, named individuals with product development responsibilities were contacted to enlist co-operation for a series of one-to-one interviews. Agreement was reached in every case and consolidated into a rolling enquiry programme monitored by a semi-structured questionnaire. (See Appendix XX). Two topics for exploration were e identified:

- Product management and implementation.

- The product.

In the latter area, a product in current manufacture was used as a tool to encourage a clearer focusing of answers. This method proved to be successful as it gave an opportunity to engage in an anecdotal exchange which gravitated naturally to the respondent's major activity. A total of five persons from each company were seen and an analysis of the data given is discussed under the Case Studies sub-section.

With reference to Case Study 'C', the position is marginally different. Here, circumstances afforded a catchment of 23 personnel engaged in the product development cycle; encapsulating product policy, design, pre-production planning, technical management support and production. The Study traces the progress of a group of designs from inception to the point of authorization for bulk production under the auspices of three research aims:

- Examination of the structure and organization of the development timetable for the introduction of new products.

- Observation of the interaction in the evolution of newly released products between those responsible in the factories and those concerned with other aspects of the development timetable.

- Identification of the factors contributing or otherwise to the product's eventual acceptance for bulk production.

In addition, and preceding the actual research period, a 'design to manufacture familiarization project' was authorised with the objective of obtaining an overview of the business's product as it related to the production methods employed. Similar dialogue techniques and questionnaire format to those previously adopted were used as a means to measure the compatibility of any eventual findings. (See Appendix YY).

Running in parallel were a series of informal discussions conducted with a group of individuals experienced in the manufacturing sector and independent of the Case Study companies, the objective being the addition of a further dimension to the matrix of information. Interviews were guided by questions framed to match the interests and writings of the interviewee.

The Case Studies section analyses the findings of each separately as the wealth of material and anecdotal comment received appeared to warrant such attention to detail. The predominant themes are finally consolidated and summarized under the headings, Development Cycle, Communication and Product Strategy.

The Interface of Design and Production

Despite the divergent profile in terms of scale, technology employed and the actual product manufactured by the three enterprises studied, certain areas of common experience are clearly discernable. Before examining these in any depth, it may be useful to reiterate briefly the principal stages of the product development cycle as recorded by a number of authorities.

The structure of the Case Study questionnaire was deliberately slanted to focus attention on the product's transition from a conceptual status, possibly supported by working prototypes, to a reality for sale or use in the market place. As a result of a considerable degree of cumulative research, good practice methods for administrating and monitoring this and other phases of the product cycle have gradually found acceptance, especially within some larger enterprises. Many alternative systems have been devised to cope with differing experience, but despite the variants one single characteristic does stand out, namely, the product will pass a series of decision taking gates regulated by established criteria. These may, depending on the management style adopted, be either formulated corporately and applied with a reasonable degree of latitude by those responsible, or established at the outset of each project brief, the company relying on a common culture element within the organization to provide the necessary level of control. Between these two extremes of the spectrum lie a host of semi or non structured approaches, many of which can be attributed to a reservoir of experience, or just the application of common sense. Researchers have, however, also demonstrated to a reasonable level of agreement the sequential nature of the activities that contribute to the completion of an average product cycle and providing, it is claimed, these are subjected to normal management disciplines, the project will more than likely achieve a viable outcome. The attraction of such a scenario has naturally lead to the creation of yet another, if not fully recognized area of organizational expertise, commonly referred to as 'Design Management'.

Whether there is a need for such a skill is another matter, but of no concern here other than to report its current topicality, and potential as seen by its supporters for becoming one of the tools to improve the economic performance of British Manufacturing Industry.

Accepting for the moment the viability of the framework outlined, the majority of system models advanced since Michael Farr's (19) 1960 Book "Design Management" have readily acknowledged the existence and importance of the design and production interface, even if on occasion the depth of detail has veered towards the slight. Professor Archer's (3) analysis, as presented in a series of lectures sponsored by the Canadian Office of Design and Electrohome Ltd., gives a very clear view of the process, dividing it into ten distinct stages. They are described as:

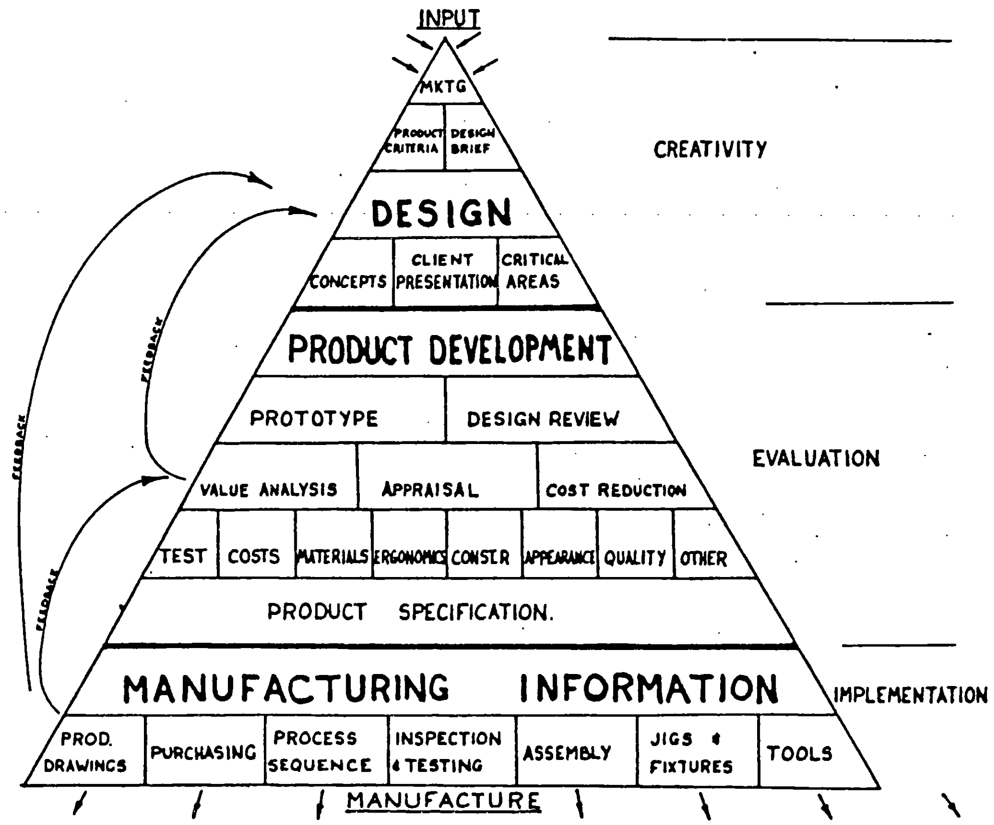
KEY FUNCTION	SUB-FUNCTION	% of Total Project Cost
Strategic Planning	Stage 1 Policy Formulation	5
Research	Stage 2 Preliminary Research Stage 3 Feasibility Study	10
Design	Stage 4 Design Development Stage 5 Prototype Development Stage 6 Trading Study	15
Development	Stage 7 Production Department Stage 8 Production Planning	50
Manufacture/ Marketing Start-Up	Stage 9 Tooling & Market Preparation	20
Production	Stage 10 Production and Sale	0

The model graphically demonstrates two factors which are of considerable interest to the Case Study findings. Firstly, stages 3 and 6 represent two watersheds within the cycle, the latter marking the point of virtually no return once a decision to go into production has been taken. Secondly, the cost of the development activity up to stage 6 has been relatively modest, enabling those involved to evaluate the product's potential without incurring serious cost penalties. However, the introduction of stages 7 and 8 creates a new set of conditions, the primary characteristics of which are escalating development costs and an enlarged communications network brought about by the inclusion of expertise not previously utilized. For some inexplicable reason, Archer's lucid exposition of the process to his specialist audience excluded any detailed reference to the implementation issues raised. Whether it was believed the occesion and title of the series, 'Design Awareness and Planned Creativity' precluded debate, or production disciplines were felt to be more associated with interpretive skills rather than origination is unclear, but comments volunteered from Case Study respondents located in production functions certainly give quite a contrary view. In fact, the reluctance to accord production personnel a creative dimension on equal terms to design, other than a possible role in the modification of details, permeates a large section of informed opinion.

Sir Kenneth Corfield's NEDO Report (13) reinforces this trend, maybe inadvertently, by relegating production disciplines to a fringe, if not supportive activity. Recognition does come at the fifth and ninth phases of an envisaged 11 stage cycle, responsibility being given for, amongst others, tasks associated with materials and labour utilization, overhead costs, process planning, tool procurement and lead times. A minor involvement is noted at phase 3, where production, in conjunction with marketing, finance and legal expertise, evaluate the relevance of the product under a number of capability headings. The views expressed in this section of the report incline towards a rather mechanistic perspective of the process, the majority of the 11 stages being classified as the responsibility of a single department. Little mention is made of sector overlaps or the cross fertilization of ideas on a structured basis, other than the listed 'design review'. conceived as a management tool for the bringing together of those involved to 'discuss the progress in detail against the specification'. At this point, considerable attention is given to the need for collaboration, but on an advisory and not a decision making basis. However, the most disturbing aspect of the whole model is the tendancy to divide the cycle into single centred activities, with minimal lateral connections.

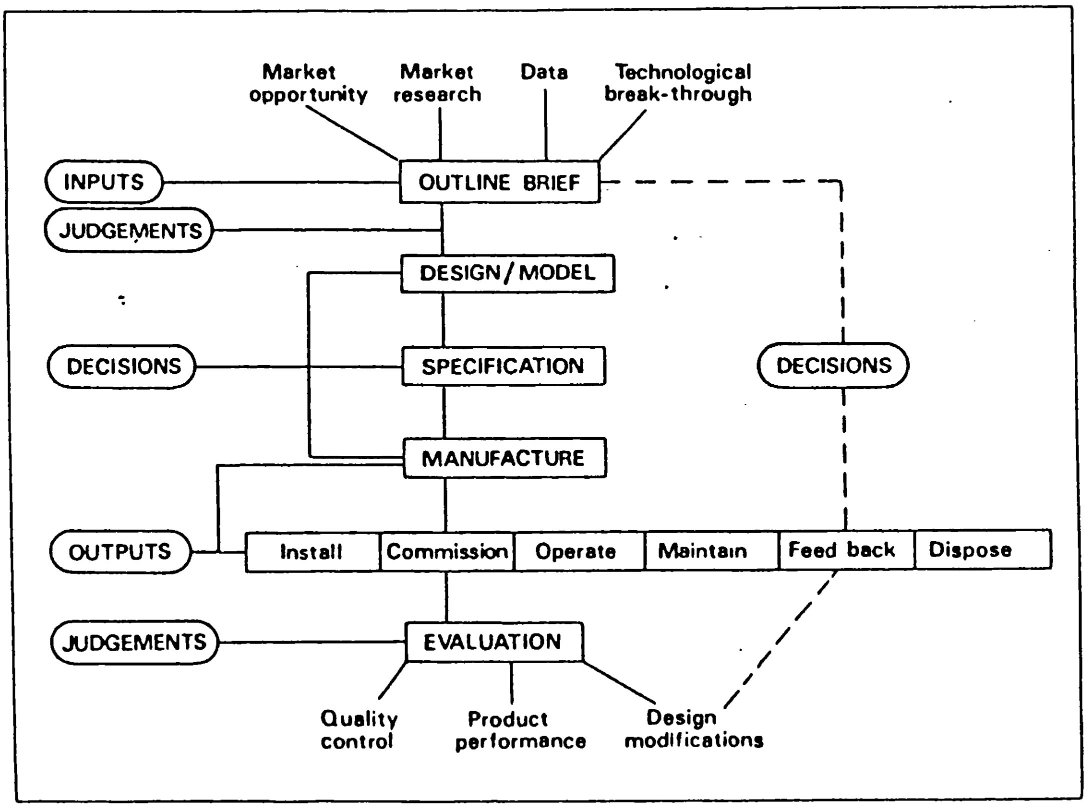
A more sympathetic view is put forward in the Furniture Industry Research Association's (37) product design and development model, which, despite the pyramidal shape (figure 1), does illustrate a need for a contribution to be built upon a broad church of related manufacturing skills, with feed-back loops to design, value analysis, appraisal and cost reduction. Irrespective of the rather unfortunate decision to break the whole process into three horizontal segments, creativity, evaluation and implementation, the interdependance of the cycle's various problem solvers is plainly visible. However, the format appears to again, perpetuate the myth that marketing and design have a natural monopoly of creative ability.

Figure 1



Pyramid design of a product design and development process.
Furniture Industry Research Association model.

Figure 2



The Design Process.
Frank Wolstenholme model.

Frank Wolstenholme (51) puts forward a totally different view by arguing that the design/model and manufacturing components are interactive, and therefore of equal status within the whole development process. His concept shown in Figure 2 suggests, there is not only a need for a closer and more imaginative liaison between the two sectors, but also a requirement for the skill base of the development team to be broadend, in order to provide greater guarantees for eventual success as the project moves from one stage to the next. It is interesting to observe, how the outline brief is expected to incorporate research into market opportunities, data collation and a technological breakthrough as mandatory elements, all of which are subjected to evaluation and judgement by the project group, prior to the commencement of any detailed design work. The whole process is seen as cyclical, the moderating status of the inputs and outputs playing a very critical part in the formation of any solution offered to the end user. For such a concept to work, he goes on to ask, 'Should not our workshops include a design area to help forge the link between the designing and making activities.

Burns and Stalker (11) clearly identified the complexity of trying to forge this link, not only in terms of designing organizational structures to assist the protagonists to achieve through regular contact, genuine feelings of mutual respect, but also, the difficulty of making those adjustments to the political climate, that would cause any such changed relationships to become clearly visible. One of the fundamental issues raised concerned what they termed as 'a linguistic ' problem' that lead to 'this tremendous gulf', an observation underlined by one of their informal interviews, where the head of the drawing office annunciated some of the problems experienced.

'The physicists would ask for a certain accuracy and the draughtsman would promise them pretty well anything, and when it came to making the job, it was found just utterly impossible to do this and we found that we didn't have sufficient tolerances to make individual parts..................................
We develop and make a model in the lab workshop. This would be tested in the lab and found to be all right. Then we might make about half a dozen in pre-production and test them in the lab. They would all be hand fitted, hand made and found to be fine. Then we would take the job and decide to make 1000 off in production and of course the Production Engineer immediately rejected most of the drawings as being infit - absolutely unfit - for production. The result was you got a tremendous gulf between the experimental side and the production side'.

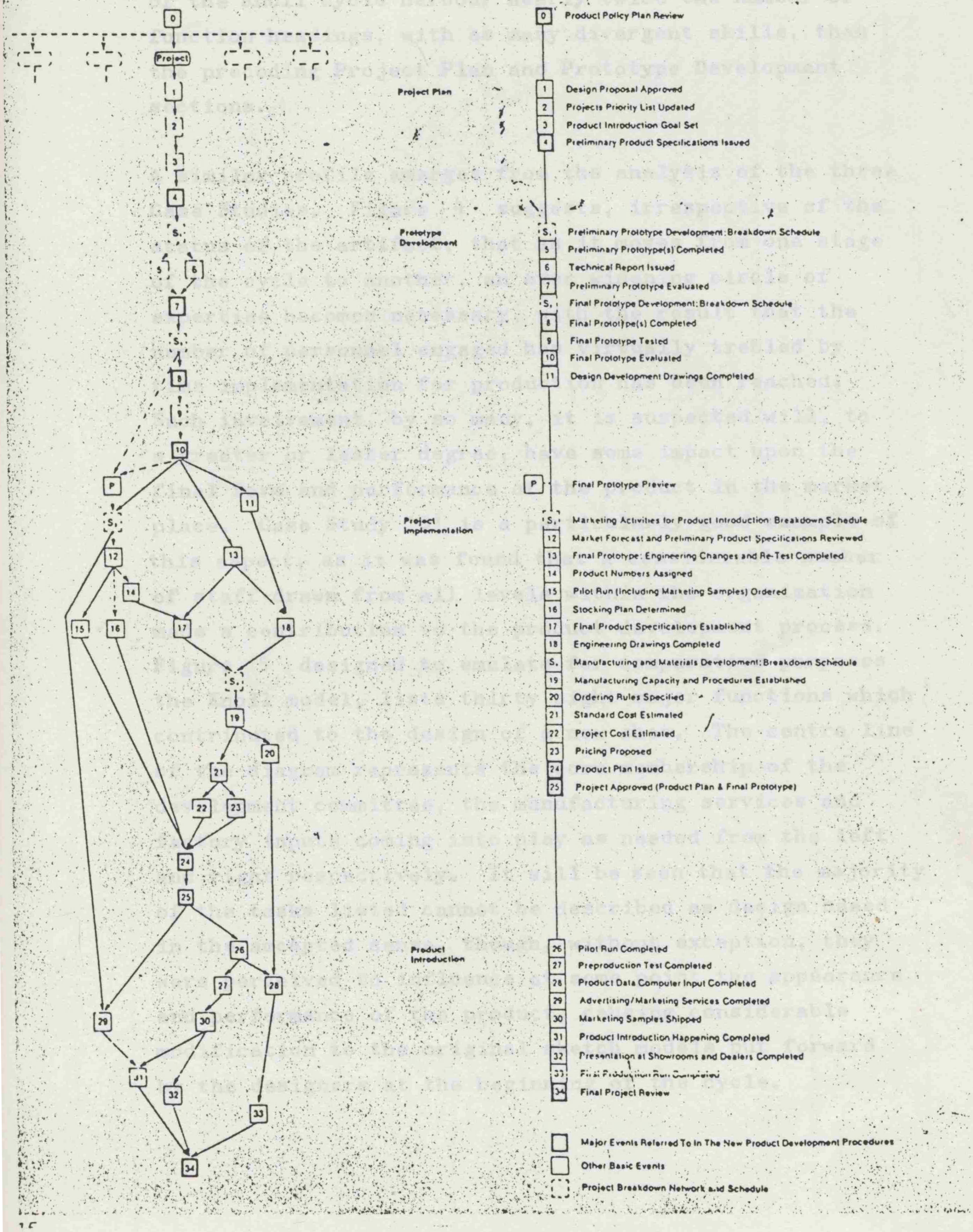
These succinct comments, attributable to a study undertaken in the late 50's, are as relevant today and to a lesser or greater degree, reflect depressingly the overall tenor of the Case Study findings. The majority of staff engaged at the meeting point of design and production, including those responsible for the strategic direction and planning of the programme, had difficulty in comprehending the scope of the necessary inputs and the roles played by each. The rather frightening level of ignorance displayed with regard to the complexity of the process, even from those engaged in similar disciplines, may partially lie with the way the British have perceived design to be a romantic occupation, rooted in a milieu that owes more to the latter 19th century Arts and Crafts movement than the competitive and technologically lead reality of the present day.

For instance, one of the Case Studies housed the marketing, sales, production and design functions on the same floor, the latter being located at one end and divided by a screen. The environment for the first three was plain, functional and commonly detailed. However, upon entering the design section, a magic world of colour, open plan and informality came into view. When the inevitable question of why was posed, the response was simply "they are the designers".

The key actors, marketing looking sideways at competitors, sales disposing of the merchandise, design thinking they are the real creators and production believing they are the only true men, are hardly ever able to take the time off to see what each other is doing. The complexity is sometimes glimpsed, but never examined with the clarity it deserves as demonstrated by the Knoll International, (the American furniture producer) new products development network; see figure 3. The format graphically shows the sudden expansion of specialist interaction taking place beyond phase 12, where the product straddles the line separating development from implementation. Up to here, the activity has concentrated on prescribing a product plan, followed by a preliminary specification for the making of prototypes to test the relevance of the plan. The diagram indicates how the requisite elements rely upon a sequential decision taking pattern, each being dependent on the result of the last to move forward to the next. But, it is also realized that once implementation is agreed, the linear format adopted to date must give way to a more lateral configuration, the structure of which swells and contracts as a series of decisions, often run in parallel, plus being interactive, are taken to moderate the progress of the product during its journey to completion and market launch. This aspect is

Figure 3

New Product Development Network

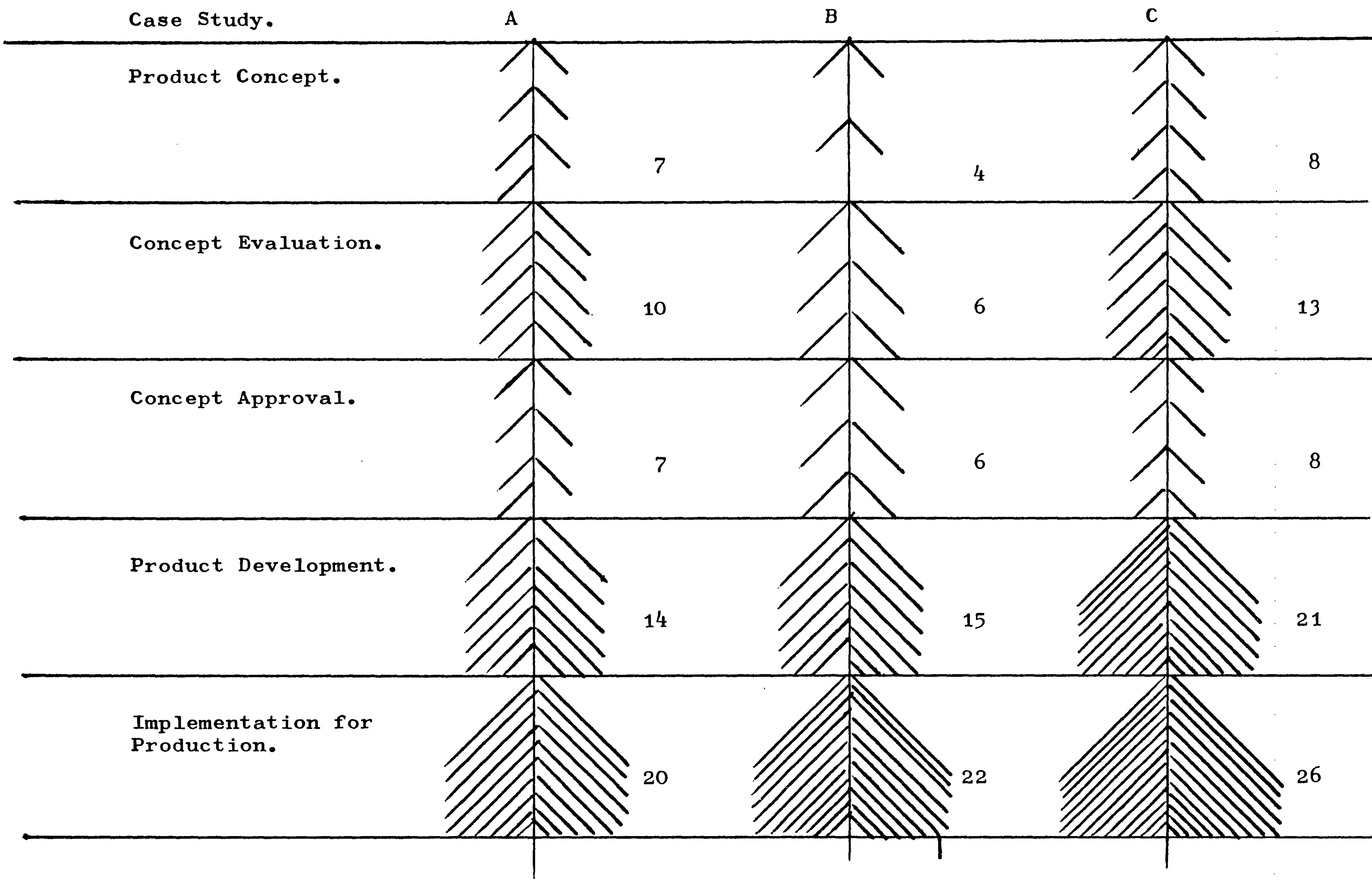


Knoll International Corporation Model. 1973 reinforced by the realization that the latter two phases of the Knoll cycle harbour nearly twice the number of function headings, with as many divergent skills, than the preceding Project Plan and Prototype Development sections.

A similar profile emerges from the analysis of the three Case Studies. Figure 4 suggests, irrespective of the status of the artifact, that as it moves from one stage of the cycle to another, an ever widening circle of expertise becomes necessary, with the result that the number of personnel engaged has virtually trebled by time implementation for production has been reached. Such involvement, by so many, it is suspected will, to a greater or lesser degree, have some impact upon the final form and performance of the product in the market place. Case Study 'C' is a particularly good example of this aspect, as it was found that a considerable number of staff drawn from all levels within the organization made a contribution to the product development process. Figure 5 designed to emulate for comparative purposes the Knoll model, lists thirty eight major functions which contributed to the design of a new shoe. The centre line of the diagram represents the core membership of the development committee, the manufacturing services and factory inputs coming into play as needed from the left and right respectively. It will be seen that the majority of the tasks listed cannot be described as design based in the accepted sense, though, without exception, they were perceived to influence at some point the appearance and performance of the product, causing considerable modification to the original sketch models put forward by the designers at the beginning of the cycle.

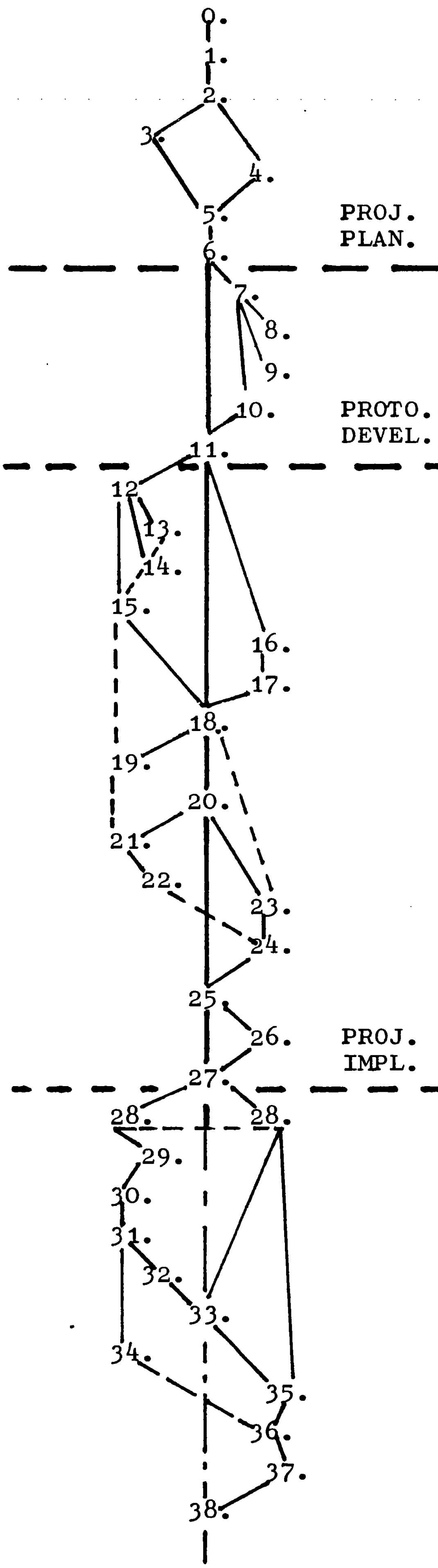
Case Studies 'A' 'B' and 'C'.- Expansion of specialist interaction

Figure 4



Case Study 'C'
Knoll comparative based model.

Figure 5



0. Development Committee.
1. Season Strategy, Meet. 1.
2. Sketch design proposals.
3. Design models.
4. Factory mock-ups.
5. Prod. Rev. Devel Meet. 2.
6. Design modifications.
7. Prod. Intro to factory.
8. Fact. Style Developer.
9. Proj. Enginering
10. Pattern Cutting.
11. Range Review, Meet. 3.
12. Manufacturing services.
13. Size samples.
14. Fit tests.
15. Mould design.
16. Making pool tests.
17. Closing pool tests.
18. Samples Review, Meet 4.
19. Tools, Travellers samples.
20. Final Review, Meet. 5.
21. Fit and Wear tests.
22. Materials Testing.
23. First factory samples.
24. Samples, quality check.
25. Range Review, Meet. 6.
26. Travellers samples ready.
27. Sales Conference.
28. Prep. of market samples.
29. Sample size patterns.
30. Pattern grading.
31. Mould making.
32. Die and knife making.
33. Inspection.
34. Ord. Equip for bulk prod.
35. Factory Pathfinder.
36. Ready for bulk prod.
37. Warehouse.
38. Delivery of samples to retail outlets.

In this case, the system used for progressing new design initiatives resided within the 'Development Committee', who excercised overall responsibility for direction and control. A product plan was determined at the beginning with presentation of market information sourced from the central services of the group, which laid out the aims of the development programme and identified the product slots requiring design attention. The Committee membership incorporated eight elements, the Divisional Director, marketing, sales, design, three product managers and the divisional production manager. All had access to resources for realising the product plan, the Product Range Managers acting as champions for defined segments throughout the cycle, though in reality the first two phases, Project Plan and Prototype Development received, significantly, the greatest attention.

Examination of the first 6 headings in figure 5 shows a market and design led situation with a marginal connection to the factory (geographically separated) taking place at the fourth step. Communications here are relatively simple, the factory liaison being maintained by telephone, sketches in the post or visits. Factors 7 to 11 retain a similar structure, though the utilization of key factory based staff, in particular the style developer, become more marked. During these eleven steps, the general flow has been vertical, evolutionary, and the decisions taken monitored by a peer group whose composition has not changed. However, as in the Knoll model, step 12 sees a sudden expansion in the introduction of inputs, manufacturing services for the first time and an increasing factory influence, who between them outnumber by 2 : 1 the membership of the development committee. The impact is further heightened by the diversity of the skills introduced, ranging from fit and materials testing technicians to foremen operating on the shop floor.

The main threads to influence the appearance and performance of the adopted design in case study 'C' came from two, possibly three sources, namely, the factory based style developer and foremen responsible for the key production processes, and the footfitting assessor/ consultant located within the Group's manufacturing services division. From within these three, the style developer exerted the strongest pull on events by acting as the unrecognized go-between for the development committee and the specialist centres engaged on implementing the decisions taken for production. The job description states:

> 'Information concerning new styles received from Factory Manager, Product Line Manager, and Stylists (designers)....to be interpreted to produce acceptable styles in design appearance and fitting qualities for production. .....Produce samples from these bearing in mind fitting proportions, bulk production suitability, stitching, S.M. content and leather usage.'

From a survey conducted with 26 staff involved with the development cycle, 19 classified the style developer as the most vital, the designers gaining a poor third position with eight votes. In addition, enquiry revealed the designers tending to withdraw from the design and manufacture interface after step 12, contact being limited to the scheduled meetings, stages 18, 20, 25, 27 and 31, (figure 5) and reaction to queries as and when raised; a view supported by one of the Product Line Managers when he said, 'Designers wish to get on with the next product and tend to be disinterested in mass production'. The designers countered this by reporting a reluctance from factory personnel to include them, a sentiment echoed when staff undertaking a fitting session on a new shoe, jokingly admitted they always politely invited them to attend, but possibly with limited notice! Nevertheless, despite the banter and unofficial demarcation, the majority of the designers still placed the Style Developer as first of the three most important contributors to the cycle.

With so many of the respondents recognizing the position of the style developer, it seemed odd that he should be excluded from membership of the Development Committee. The reason could possibly lie more with the terms used to describe the remaining 26 steps, figure 5 , the words listed being taken from those in regular use by the sections responsible for the various tasks. Phrases such as 'fit tests' or 'making pool tests' do not immediately conjure up images normally associated with the design process. Quite to the contrary, all of the development committee members, including design and production, never mentioned such activities in the same breadth as design, believing, it is suspected, they belonged more to jobs connected to repetitive production techniques, rather than as a means for innovatively applying established know-how to solve conceptual design problems. For example, initiation of step 14 'Fit Tests' (Figure 5), caused a lateral expansion of the inputs required for this stage; involving staff from manufacturing services, the committee, the factory designated to produce the shoe and five infant girls seconded from the local school, see figure 6 below:

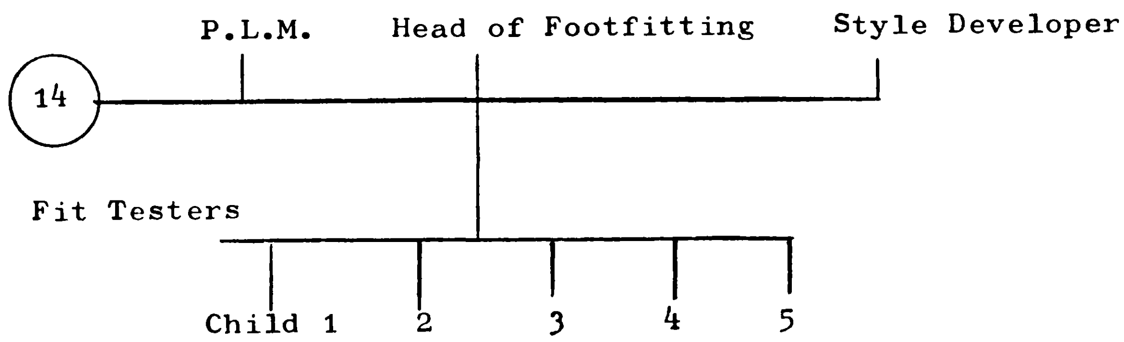


Figure 6

During the testing sessions, the children were encouraged to handle the products, try them for size, fit and comfort, plus express opinions and preferences with regard to style and colour. As a result, this excercise in user/maker interaction concluded with a crop of relatively critical issues, such as the sole of the shoe protruding well beyond the toes or the inappropriate positioning and shape of the rear straps. In other words, comfort, wear and style had moved into a state of tension, causing design modifications which, because of the tight marketing schedule had to be resolved quickly and on the spot. Despite the modest nature of each change, as agreed, the cumulative affect produced an amendment to the styling line of the shoe. Therefore, although the Product Line Manager was the Product's champion, in reality the children, the style developer and the fit assessor managed to collectively determine the outcome of the session.

Similarly, on another occasion (step 28), the cutting and making foremen of the factory where the shoe was going to be made, identified technical difficulties with colour matching the heel support to the front straps and providing adequate wear strength for the latter. Both of these developments demanded the assistance of laboratory technicians and/or external material suppliers. Again, visual adjustments became necessary, with the result that the original conceptual model as submitted by the designers to the Development Committee and approved at phase 11, was further compromised. However, the committee was already caught up with the next seasonal programme and though consulted, was in no position to influence the course of events. It was simply too late.

Further, as the cycle gained momentum, it spawned a host of specific expertise mini cells that were laterally linked by the development process, though not knowingly to the majority of members, other than via circumstantial contact or knowledge gained from long association with the business. However, together they managed to unearth a rising tide of technical issues, that brought into focus the never ending dilemma of appearance versus the practicality for production. Within days of the marketing decision (step 11), three implementation problems were being examined; by the Sales Conference (step 27), the total had risen to five, with a corresponding increase in the number of participants. So although Figure 5 shows an expanding trend of interactivity at the official level, particularly from step 11 onwards, a second, but hidden layer of problem solving expertise was being deployed in parallel at cell level, which because of the lateral linkages between each of them and those formally recognized, produced a communications network of three dimensional proportions. Nowhere was this more apparent during the investigation than at the meeting point of design and production; graphically illustrated when a critical path laying out the steps necessary for the procurment of last moulds was accidently discovered. Designed by one of the Style Developers, it listed in diagrammatical form a sequence of 43 key actions for producing a tool to mould a shoe sole. Tasks ranged from the reservation of space within the production schedule for the supply of the tools to working with designers, mould makers and other craftsmen to determine the details and quality assurance of the tool design. Certainly, the traditional method of handing over a design from one department to another with minimal cross referencing to colleagues, bears little relationship to the findings just described.

In fact, an incident recounted by a senior respondent located in the same Case Study demonstrated how, as a result of design, technical development and production co-operation a serious trading loss was turned into a profit within two years. The division in question, located overseas, had been for some time suffering a decline of market share, due to poor products, low quality and out moded production methods. The newly appointed Managing Director had a strong personal interest in the design process and decided on arrival to engage a new designer, plus second for three months from the parent company a highly qualified technician. The engendered design/technical collaboration produced a manufacturing system which became known as 'Slip-lasting' and lead to new product opportunities. The initial co-operation between the two disciplines was consolidated by the creation of a weekly meeting, which brought together the key managers, including production, to discuss the business's central purpose, the product.

The seconded technician was able, because of earlier factory experience, to become in many ways the catalyst for controlled change, assisting the designer to realise novel ideas through the application of his innovatory technology, whilst persuading the factory unit to accept change to produce a quality product. The technician's background was a major factor in convincing a very experienced, but conservative Production Director to adopt the new products and making methods offered. Although eventual success rested heavily upon the product orientation of the company from the top, the author of the incident insisted the gelling of the designer/technologist equation became the vital ingredient in the mix. The event is a classic case and supports the findings of a Government report (5) that recommended amongst other proposals 'The direct linkage of R & D, production and marketing into a single interacting operation'.

None of the Case Studies had internal organizational structures to promote or make such a 'direct linkage' or were able to perceive the scope and breadth of the resources needed to guarantee an effective development programme. On the other hand, the expansion of the skill base, especially at the latter stages was a common characteristic, implying that possibly the majority of respondents held a rather narrowly defined view of the design function. The former conclusion is clearly supported by the analysis of each study and singularly so in the case of 'B', where the published Control Systems Manual failed to mention, even in visual terms, the place and format of the product cycle within the company; despite stipulating in great detail the procedures which were to be followed by departments for executing new product programmes. Such contradictory behaviour is again echoed by interviewee answers to questions exploring the profile, sequence and priorities of the development cycle. Without exception, it was found each sector's specialist functions and associated tasks dominated the thinking horizons; matched only by an equally comparable vagueness as to what occurred before or after the product came into contact with that sector's interests. Similarly, the absence of a common understanding of what constituted the key go/no go decision points occurred at nearly all levels of product development responsibility.

Possibly these comprehension and lateral communication difficulties can, in part, be further explained by the progessively lengthening timescale of the cycle as it moved across the four activity zones illustrated in Figure 3 ; where those engaged, say at opposite ends of the product development process are either ignorant of, or have lost sight of each other's contribution to the whole, for a successful product launch. For as

Case Study 'C' (Figure 5), based on the Knoll model demonstrates, when the emerging product straddles the prototype to realization binary line, the timescale also inexorably lengthens to meet the growing level of sectional interactivity to resolve the practical issues raised by the prototype. Hence, the combination of the previously noted expansion of the skill base with that of time in the latter stages of the cycle, may, unknowingly to the authors of the design concept, give the implementors a larger than imagined influence over what eventually reaches the market place. Whether this is the case or not, Table 'A' records a clear top loaded time element in zone 'B' for studies 'A' and 'C' respectivily and a balanced split for case 'B', despite the high technology characteristics of the Company's product.

Timescale in months — Table 'A'

Zone	'A'		'B'				
Activ.	Proj. Plan.	Proto. Devel.	Proj. Impl.	Prod. Intr.			
Case Study.	Time.				Total	% A	% B
A	2- 3	2- 3	11-18	8-12	24-36	17	83.
B	6-12	12-18	12-18	6-12	36-60	50	50.
C	1- 2	1- 2	3- 5	1- 3	6-12	34	66.

This division of the time element is also interestingly explored, though for different purposes, by a study conducted for the CBI, 'Investment lead times in British manufacturing industry'. (7) The postal questionnaire phase of the survey asked respondents to record the lead times experienced against the four stages:

" I: From the start of development work after fundamental research to the date of Board authorisation of the main capital expenditure;

II: From the date of Board authorisation to the date on which the principal contract is placed;

III: From the date on which the principle contract is placed to the date on which construction or installation is begun;

IV: From the date on which construction or installation is begun to the time when regular production is under way on a full commercial basis. "

Stages III and IV can be compared to the Project Implementation and Product Introduction catagories identified for zone 'B' in table 'A' , with stages I and II having similar parallels to the zone 'A' activities. The Bath researchers found, amongst others, three trends that do on the surface lend support to the findings reported in Table 'A'. First, the average lead time for all four stages of the 136 projects reviewed was 29 months, the shortest taking 6 and the longest 71 months. Secondly, the division of time between stages I/II (zone A) and III/IV (zone B)was on a percentage ratio of 44 to 56 for the two zones. Thirdly, the construction time (stage IV) was more than often the longest period, followed closely by the time spent on development work (stage I), before the Board gave the final go-ahead. We shall return to the last point later in this chapter, but it is worth noting that some of the major reasons for the length of time expended on stage IV, were due to delays caused by either technical construction difficulties, late delivery or hold-ups in the commissioning of the production plant. Figure 7, extracted from one of the CBI Case Studies does show a similar utilization of time for that established in the research conducted here.

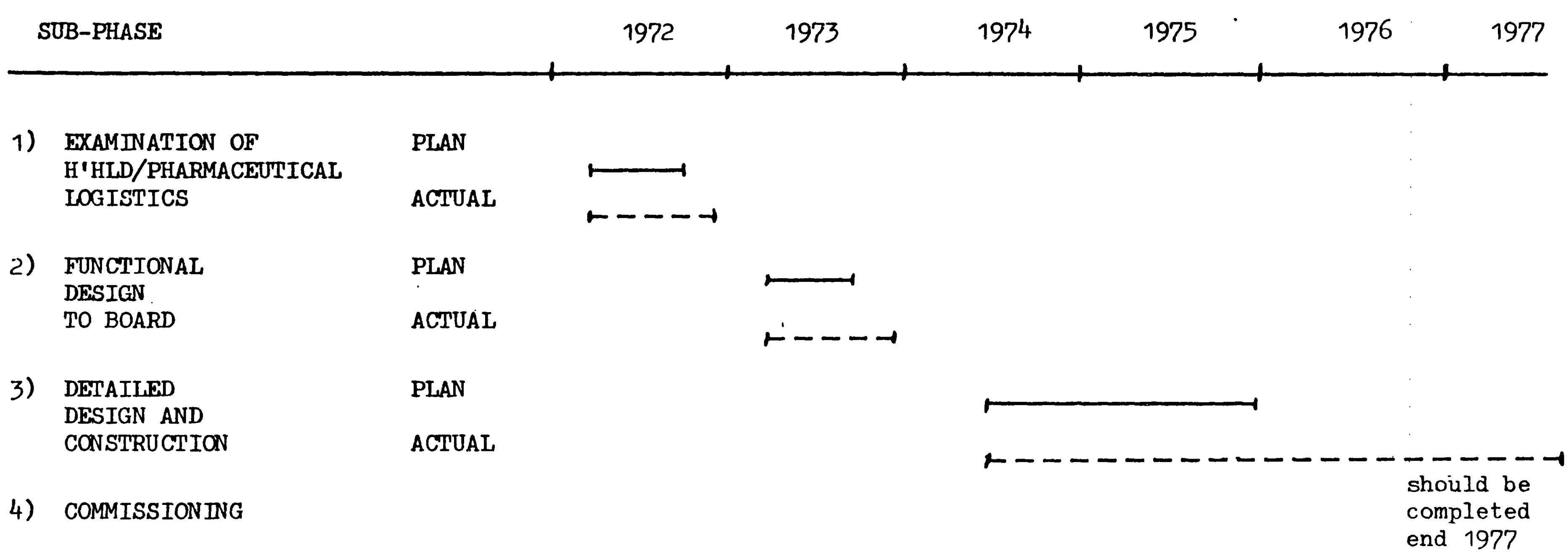


FIGURE 7

Source: The University of Bath, School of Management.

Last but no least, the spread of respondent opinion in respect of the duration and the quantity of people involved with the development cycle is confirmed in Table B, the answer repetition shown by the density of the dots. Variations in perception can be seen by sector and within sectors, giving added credance to the conclusion that none of the case studies demonstrated a cohesive view of the cycle.

So far three factors of critical interest have come into focus, namely:

- A widening skill base, coupled to an extended time scale for the latter stages of the cycle.
- Difficulties encountered by individuals in visualizing the scope and breadth of the cycle and their place within it.
- Absence of formal arrangements to facilitate closer contact between personnel working in the design and production sections.

However, before looking at two others, product awareness and strategy, it needs to be stressed that the findings just listed have emerged from companies who use systems for managing the cycle that have proven good practice characteristics. Table C illustrates the major parts. It will be seen that in all instances a group or committee was formed to lead the project or development programme, the cycle is structured into defined phases and relatively informal methods of communication are practiced; the exception being case study 'B' where a slightly more hierarical attitude was the custom. In such circumstances, it would have been reasonable to expect a good level of intersectional dialogue, both vertically and laterally, and especially with case study 'A' where the staff concerned occupied a single building.

Product Development Cycle.. TABLE. B.

QUESTION		ANSWERS	A COMMERCIAL	A DESIGN ENGS	A MANUFACT.	B COMMERCIAL	B DESIGN ENGS	B MANUFACT.	C COMMERCIAL	C DESIGN ENGS	C MANUFACT.
PRODUCT DEVELOPMENT	HOW LONG DOES IT TAKE	DON'T KNOW.			•			•			
		TWO - THREE MONTHS.				•					
		SIX - NINE MONTHS.					•		•	••••	
		TWELVE - FIFTEEN MONTHS.									••••••
		EIGHTEEN - TWENTY FOUR MONTHS.	•	•	•						
		NOT LESS THAN TWO YEARS.		•							
		THREE - FIVE YEARS.					•				
		LEAD TIME VARIES - TWO YEARS TO DECADE.					•				
	NUMBER OF PEOPLE	TWO - SIX.		•					••	•	•
		SEVEN - FOURTEEN.	•			•			•		•••••
		EIGHT - TWELVE.		•					••	••	••••••
		FIFTEEN - EIGHTEEN.					••				
		OVER TWENTY.							•	•	
		VARIES.			•			•			

Table C.

Product Cycle - Common factors, all case studies.

Item	Case Study A	B	C
1 Method of Management.	Project Group.	New Business Committee.	Development Timetable Committee.
2 Leader.	Chief Executive.	Business Planning Manager. and Project Engineer.	Divisional Director. and Product Range Manager.
3 Sections involved in addition to 1 and 2 above.	Design Engineers. Production. External Suppliers.	Commercial. Design Engineers. Production.	Design. Sales. Marketing. Manufacturing Services. Factories.
4 Key phases.	5 major.	4 major.	7 major.
5 Communications.	Informal. No lateral.	Semi-formal. No lateral.	Informal. No lateral.
6 Product cycle overview.	Some, chief executive + other directors. No formal view.	Some at design engineer level. No formal view.	Some, but fragmented. No formal view.

Although the vertical relationships, that is communications within a sector or department worked to an acceptable standard as per the good practice principles laid out in Table 'C' ; the passing of data across boundaries, even when classified as for information only, proved to be more problematic. A classic incident was witnessed in case study 'C', when the designers released an outline new product specification to the factory responsible for manufacture. At the first meeting called to agree production methods, the assembled company, many of whom had never seen the prototype, experienced great difficulty in visualizing the actual appearance of the new design. This was primarily due to the format adopted for the specification, (Figure 8), so dry that possibly it may have felt more at home in a stock control system, than as a tool for influencing shop floor sceptics into a constructive frame of mind. If such an approach had been used by a section other than design, e.g. work study, the method would have at least been more predictable. But coming from design, where tradition demands the communication of ideas by the means of graphical presentation, pencil led as opposed to the pen, the discovery came as quite a shock. Advantage was taken of the situation and eventually illustrated documents arrived on the Style Developer's desk, acting like a charm when it came to resolving those minor queries over the telephone.

Returning to case study 'A', the single sited location of design and production did help to create an atmosphere that enabled a genuine transfer of knowledge to take place. However, because of the absence of purchasing from the early stages of the cycle, a key function for a company with no in-house material conversion resources; even the close juxtaposition did not prevent a certain degree of sourness at interpersonnel level. As the Purchasing Manager wryly remarked in one session, 'Our late entry into new product

~~GENDER~~ : BOYS
SEASON : SUMMER 1984
RANGE : CASUALS

SLOT SUMMARY

DATE ISSUED : 3.3.83
ISSUED BY : AMM

SLOT NO.	FACTORY AND/OR SUB RANGE GROUP	SHOE NAME	STYLE TYPE	BY SUB RANGE						REMARKS
				FITTING	SIZE RANGE	RETAIL PRICE	NO. OF LINES (SKU'S)	EXPECTED INSTOCK (I/S)	VOLUME '000 prs.	
1	St. Peters Dir. Mould P.U.	New	Shoe - Megastar suede/ nylon type	7645 DEFG	9-5½	(11-1½) £9.99				
2	Dir. Mould P.U.	New	Boot - (Sneeker-type) Megastar Suede/Nylon	7645 DEFG	9-5½	£10.99				
3	Dir. Mould P.V.C.	New	Shoe - New Commando Casual Kit?	7688 DEFG	11-5½	£9.99				
4	" " "	New	Boot - Springboard kit?	7428 DEFG	11-5½	£10.99				
5	Isca or Resourced Dir. Mould T.R.	New	Older Boys shoe - Superb Type Non-Leather	1791 FG	2-11	(2-5½) £9.99				
6	Dir. Mould T.R.	New	Older Boys Boot - Superb Type Non-leather	1791 FG	2-11	£10.99				

Figure. 8

development often finds engineers working with potential suppliers who are either unsuitable or not the most competitive'. Conversely, when this observation was put to the engineers, they tartly retorted 'they (production) do not understand the design ethic'.

During an investigation conducted by Burns & Stalker (11) into why individuals had problems of adapting to different or new conditions within an organization, they came across staff working in the laboratory or factory who had type cast opinions of each others role, both in functional and social terms. 'Physicists' they were advised by a managing director 'are very difficult people to work with'. Or remarks that described a production engineer as 'a person who can tackle any problem and solve it unaided', plus laboratory staff as 'those long haired types', or conversely 'the production clots' were also common place. Whether this was because of what they initially thought could be put down to 'these cultural differences' or as later grasped, to satisfy a gut reaction to blame the other side when the going becomes rough is relatively unimportant, what is pertinent, is that design and production interviewees from all case studies displayed similar traits. Table D, lists a series of verbatum comments made by staff from two areas. They came quite spontaneously from discussions structured to learn about job roles and establish who made what contribution to the product cycle.

The overall tenor of these design/production exchanges also finds an echo in the results of a piece of own desk research (Appendix ZZ), undertaken to evaluate the pattern of answers given to a questionnaire survey of design engineer managers, designed and conducted by Bath University. (8) It covered a number of sub-topics under a

Table D.

Case Study	Design Engineering and Production Responses.	
	Design Engineering	Production
'A'	Engineering, however, are able to contribute the detailed thinking to ensure a practical and cost effective result.	The Company is tending to run before it can walk.
	Technical staff often have ideas which are practical and saleable. The problem is to spot them.	Production resent their late entry. The Works Manager would like to become involved much earlier in the cycle.
	Once production become concerned, costs are difficult to control.	Only when the product has been in production for 18 months, is it possible to start initiating unit cost savings.
'B'	In any case, the design sector stears clear of commercial negotiations.	It has been found that Project Engineers are not cost orientated.
	A void may exist between design engineering and manufacturing.	People outside manufacturing believe there is infinite capacity.
'C'	Not really brought into factory meetings.	Why so many outstanding design details?
	Sometimes surprised to discover product specification changes without being told.	No need for the designer. Product Range Manager meetings are a load of bull!
	Usually withdraw from the project once the prototype is approved, other than background monitoring.	Too many design staff straight from College based at Headquarters with no technical or craft knowledge.

'Planning' unbrella heading, one of which was entitled, 'Planning as it affects product design and innovation'. Based on the written comments received by the University to this part of the questionnaire, the two most dominant themes were extracted from each topic within the heading. One of the conclusions to emerge was an implied breakdown in communications with regard to policy decisions, plus inter-departmental relationships at divisional level and between the group executive and the divisions themselves as corporate bodies. Another, in contrast and strongly supported by the findings of the case studies, was a high degree of personnal identification with and awareness of the Company's product, irrespective of the specialism practiced. Topics raised in the Bath survey, market awareness, competitiveness, the need for innovation and R & D are reiterated to remarkable accuracy by the views expressed here, as Tables E and F demonstrate. The questions posed were designed to elicit feedback where the product became the starting point, the intention being to neutralize, as far as possible, idiosyncrasies of respondent background and experience. Therefore, all were asked to choose a product or component, whichever was the more suitable for placement on to a desk or work bench; the physical act being enough to guarantee that the selected item could not be ignored by either party. Conversation was directed at it, through it and around it, but there it stood, silent and impervious, an ever constant reminder of the purpose and state of health of the enterprise.

The technique did generate a fluid debate, whatever the position or depth of individual involvement with the product cycle. Responses encapsulated within the two tables allow a snapshot view of the most persistant issues to be raised, many of which gain a large measure of across the board support. Factors that are perceived as leading to

Product Success Factors. Table. E.

QUESTION	Case Study.	A			B			C		
	ANSWERS	COMMERCIAL	DESIGN ENGS	MANUFACT.	COMMERCIAL	DESIGN ENGS	MANUFACT.	COMMERCIAL	DESIGN ENGS	MANUFACT.
SUCCESS FACTORS	INNOVATION.	•	••••	•••	•	••	•	••		•
	QUALITY, RELIABLE.	•	••	••	•		•	•••••	••	••••••
	COMPETITIVENESS, PERFORMANCE, VALUE.		••••	••	•	••••	•	•••••	•	•••••
	AFTER SALES SERVICE, DELIVERY.		•		•	•••				
	SIMPLE BALANCED DESIGN.	•	••	•••	•	•••		••••••	•••	••••••
	PROVEN TECHNOLOGY, DEVELOPMENT OF EXISTING.		••	•	•		••	•	•	••••••
	MEETING MARKET NEEDS.		••••		••	•••	•	••••	••	••••••
	GOOD PLANNING.		•		•	••	•			
	PROPERLY INTRODUCED TO EMPLOYEES/COST.			•			•			
	PERSONAL COMMITMENT.			•						

success, innovation, quality, competitiveness, value for money, design simplicity and meeting the needs of the market are all accorded a high score that bridges study and sector boundaries alike. In addition, it is interesting to note how the five part question, "How does the Product reflect the Company's 'Public Image'", etc, listed under Table 'F', brings out a host of reactions. Some reaffirm views stated previously under success, whilst others either resulted in difficulties of comprehension, witness public image versus market position, or clarified a believe that new product introductions did give production headaches and teething problems. This last sentiment, expressed unconsciously, may go some way to explain why so many felt the application of proven technologies, with a measure of ingremental development, was one ingredient that gave product success. (Table E). Perhaps past experiences had led to a reduced level of expectancy from the production sector, but whatever the reasons, the answers given to the last two sub-questions, manufacturing resource and long term corporate policy, betray frustration at not being able to get things done or influence the course of events.

However, in the last analysis the data does indicate a surprisingly high interest in the product from all the sectors, suggesting a lowering or abolition of function boundaries could well create an opportunity for more effective products, in terms of market appeal and in-service performance. The writer, Shapero (45) when examining the results of a project completed by MIT staff, concerning the effects of physical proximity on communications with work related zones, commented:

' I have experimented with this idea when I was a manager of several research groups and found that changing the location of a man, shifts his work

Table. F.

QUESTION		CASE STUDIES — ANSWERS	'A' DESIGN	'A' ENGINEER	'A' MANUFACTURE	'B' COMMERCIAL	'B' DESIGN+ENGINEER	'B' MANUFACTURE	'C' COMMERCIAL	'C' DESIGN	'C' MANUFACTURE
HOW DOES THE PRODUCT REFLECT THE COMPANY'S	Public Image	INNOVATIVE		•	•		••		•	•	•••••
		GOOD DESIGN			•				••••	•	••
		RELIABILITY		•	•	•		•	••••	•	••••••
		DON'T KNOW	•							•	•
	Market Position	COMPETITORS OFFER BETTER VALUE		•	••						•
		IMAGINATIVE, ECONOMIC, HI-TECH LEAD		•				•			
		DON'T KNOW, AS PUBLIC IMAGE	•						•	•••	••••••
		BECOMING A MARKET LEADER AGAIN				•	••		••••••	••	••••••••
	Innovative Capability	INNOVATIVE, NEW TECHNOLOGY			•	•	••	•	•••••	••	•••••••
		BUILT UPON KNOWN TECHNOLOGY		•	••				••	•	••••••
		COMPETITORS HAVE NOW OVERTAKEN	•	•							
	Manufacturing Resource	SATISFACTORY						•	•••••	••	•••
		IMPROVE COMPETITIVENESS	••	••			••				
		HEADACHES, TEETHING PROBLEMS		••	••	•		•	••	••	••••••••
		CHANGE NEEDED									•••••••••
	Long Term Corporate	MOVE INTO NEW PRODUCTS/LOGICAL DEVELOPMENT			•				•••••••	••	•••••••••
		LACK OF MARKET RESEARCH		•	•				••		••••••
		PRODUCT CAME ABOUT BY ACCIDENT		•							•
		DON'T KNOW	•		•	•	•			••	••
		NEW TECHNOLOGY LINKED TO ADVANCED DESIGN			•		•	•			•

related conversations and the particular flow of information in the organization. It has been said that if you put a research department next to a sales department it produces more products, if you put it near a University it produces more articles'.

Shapero's assessment, though possibly obvious, does appear to have some relevance. The matching of an environment, in which the work related interests can learn to lean over and talk to each other with a level of product awareness located in the case studies, might conceivably engender an atmosphere where co-operation becomes fun. Hamish McRae,(36) Guardian financial editor once likened Racal's success to the concept that staff found it 'fun', or alternatively the group had acquired the knack of creating an environment where intelligent people with different skills, actually got a kick out of working together. But co-operation needs leadership, implying that the leaders and the led have staked out the primary ground and reached an unspoken understanding of what constitutes the main parameters.

This dimension was patently missing from all the studies, some worse than others. Two closely linked areas were probed with staff, formulation of product policy and the existence of a product brief. The questions were unambiguous and the findings (Table G) equally precise. Senior respondents from all study 'A' sectors, commercial, design engineering and production recognized that the chairman and then the board set product policy, though further down the line the position was less clear. A brief did exist, but only the commercial and design factions had heard about it. In 'B' we have what can only be

Product Strategy and the Design Brief

Table. G.

QUESTION	ANSWERS (Case Study.)	A COMMERCIAL	A DESIGN ENGS	A MANUFACT.	B COMMERCIAL	B DESIGN ENGS	B MANUFACT.	C COMMERCIAL	C DESIGN ENGS	C MANUFACT.
WHERE IS PRODUCT POLICY FORMULATED	BOARD LEVEL.	•	••	••				••	••	•••••••
	CHAIRMAN/DIVISIONAL DIRECTOR.	•	•••	••••				••••		•••••••
	SALES/MARKETING.		•	•	••	•••	•		••	••••
	NO FORMAL BODY/DON'T KNOW.		•	•	•	••••	•	•	••	••••••
PROD BRIEF	HAVE SEEN.	•	••			••				
	DOES NOT EXIST.			•	•		•	••	••	•••••

described as a disastrous situation, where all the senior and middle managers (no directors took part) thought that either sales and marketing were responsible or simply stated they were not aware of any policy formulating body. A design brief, which could be confused with a performance specification was available to the design engineers, but other sectors had never seen it. Confusion reigned as to how and where product policy was determined in the case of 'C', reinforced by a universal ignorance as to the whereabouts of the design brief. One was eventually produced, but this took more the form of a statement, confirming the outline solution as agreed at the outset of the project, when the marketing objectives were established. Further, it was amazing to discover how many 'C' study staff believed sales and marketing devised product policy.

Another aspect to emerge was the lack of time and attention given by the three companies to product policy, strategy or the design brief. It seemed as if decisions to develop a product or enter markets came about more by accident than as deliberate policy; or as one executive put it 'decisions on new products are made on the basis of taking advantage of market opportunities as they emerge, which though encouraging an entrepreneurial atmosphere does misdirect resources'. This is in stark contrast to the CBI/Bath University study (7) where it will be recalled extensive research, prior to Board authorisation of capital expenditure, was carried out during stage 1. Is the difference in attitude due to scale, such as the construction of a new factory, unlike the drip by drip commitment of resources in the average development cycle, or is it more to do with product design being seen as an isolated activity, outside the mainstream of business investment decisions, or as Ansoff (2) maintains:

> 'In the absence of strategy, there are no rules to guide the search for new opportunities, both inside and outside the firm. Internally, the research and development department has no guidelines for its contribution to diversification. Thus the firm as a whole either passively waits for opportunities, or pursues a 'buckshot' search technique'.

Certainly, as will be shown by the following detailed analysis of each case study, there were serious product strategy deficiencies. These were further compounded by the contradictions of opinion registered to decide which qualities contributed most to product success of failure. Such concerns are again strengthened by the dominant themes extracted from the study of the earlier mentioned Bath University survey (Ap.ZZ), where the design engineer managers, in addition to a commitment to the product, portrayed a:

- Frustration at not being able to meaningfully influence events within the division or company.
- Incomprehension as to why effective action to combat decline and erosion of market share was not a top priority.
- Regret at not being involved in the mechanics of determining the direction and profile of product policy.

These empirical findings, it is believed, can be treated as lending support to Ansoff's thesis, that in the absence of any clear direction, the business will either wait for something to come up or consume valuable resources, with nothing to show for it at the end. Admittedly the sample is small, but possibly the trends could be considered to have some relevance, bearing in mind the current economic performance of British manufacturing industry.

The Case Studies

CASE STUDY 'A'

Historical Background

The business was started 27 years ago, founded upon a concept by the owner to design and manufacture a component for regulating the flow of liquids, oil, gas and other fluids normally associated with the utility industries. Today the Company generates a £20million + turnover, manufactures from a purpose built factory and sources market intelligence from a network of 70 Sales Offices.

At the end of the Second World War the British equipment suppliers to many of the utility industries were old-fashioned, conservative and marketing a product whose basic design had not changed for decades. The owner, who at that time was running in partnership a small engineering concern, was approached to manufacture under contract one of these traditional products. Examination soon confirmed the design's inadequacy when viewed against an oil industry who were already then considering the building of larger and more complex refineries. Such a situation called for a re-think, entailing a move from the traditional view of localised on-site control to a centralized system, designed to meet newly emerging safety standards without jeopardizing operational efficiency.

Consequently, a radically different product was conceived and prototyped for demonstration to existing manufacturers, who it was hoped would be sufficiently interested to consider marketing it under a licence agreement. Unfortunately the established industry showed a singular lack of enthusiasm and after considerable frustration it was realized the only way for the product to be manufactured would be through the creation of a new and separate business.

The Company was born in 1956 and operated from the rear of the owner's private residence with a team of five. Initial success lead to a recapitalization in 1957 which by 1959 was producing a turnover of £250,000 per annum with 50 employees. During this period a contract of international significance was won that enabled the unique and innovatory features of the product to be properly tested in the field. The contract included the use of a number of standard components which needed to be supplied by existing manufacturers. These were eventually provided, though reluctantly and on the understanding the Company would accept full responsibility for on-site installation and operation.

This early success laid the foundations for a public flotation in the late Sixties and the development of close working ties, as opposed to earlier disassociation with the specialist manufacturing fraternity.

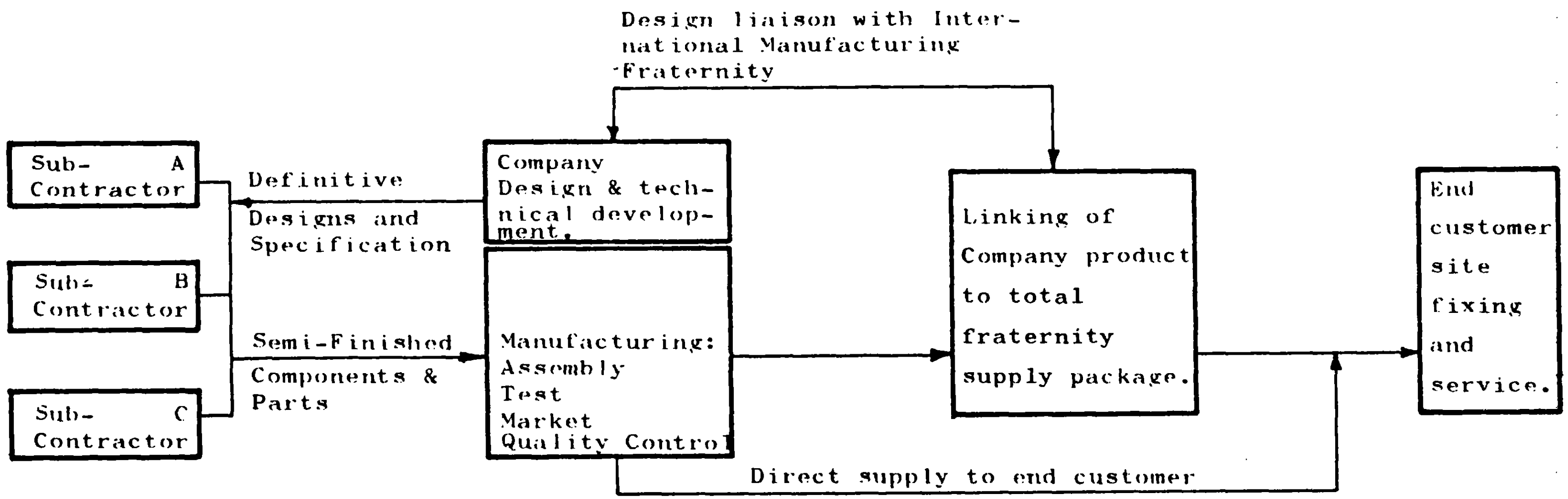
Manufacturing Resource

An unusual but important philosophical thread runs through the enterprise's thinking with regards to manufacturing, probably formulated during the early years due to the absence of making resources, but through experience now consolidated into a series of guiding principles. The Company does not actually manufacture in the conventionally accepted sense by converting raw or semi-processed materials into finished products. Instead it has deployed design leadership to formulate technically innovative relationships with carefully selected sub-contractors who are equally expected to make a creative response to ensure successful on-site installation of the product. Therefore the business's manufacturing profile can be described as sub-contractual, the common link being the design and technical leadership exerted upon all the other parties concerned as illustrated in Figure 9.

This approach has encouraged the formation of a tripartite force into a powerful marketing tool, the Company undertaking the catalystic functions between a sandwich of sub-contractors and end users, the effective interdependence of the three parts equalling the success and profitability of the whole. Although the sandwich's outer layers are recognized to be independent, able to choose with whom they wish to treaty, success is ultimately dependent upon the quality and innovatory performance of the product. It is this principle that appears to have guided the Company's attitude to manufacturing resources, the characteristics of which can be summarized as follows:

CASE STUDY 'A'

FIGURE 9



THE SUB-CONTRACTUAL PROFILE

- Self-sufficiency in design and technical specification.
- The sub-contracting of the product's components to third parties possessing the appropriate material conversion skills with a stretching of production facilities and technical expertise to meet market generated solutions.
- The in-house assembly of components into finished products, coupled to a monitoring of purchased component quality and testing prior to customer despatch.
- An after sales service dedicated to on-site component replacement.

Consequently, the overall management thrust is designed to maximise the skills of sub-contractors by the application of specification lead purchasing policies. This in turn releases financial resources for product development, technical and customer services with a minimum commitment to fixed assets.

The emphasis is upon knowledge as opposed to a materials conversion based business, giving priority to the manufacture of value added products that are perceived by the market place to be innovatory.

Design and Technology

The Founder's background, a blend of architectural training and an interest in engineering underpinned by a family capability, has probably been one of the key reasons for the successful harmonization of the market, design and manufacturing dimensions. Although such a holistic attitude is clearly visible, as in 1956, the Company is still product lead as opposed to market dominated, the belief being that markets will modify positions if offered the choice to move forward on a basis of improved profitability.

This assumption is partially supported by recent events where the Chairman withdrew from daily operational control to concentrate more on the strategic direction of the Group. The policy change came about for a variety of reasons, but the nett effect was a failure to introduce during the period in question market sensitive products, causing turnover growth to stagnate in real terms and giving competitors a heaven sent opportunity to increase market share. The damage is recognized and steps have been taken to re-establish the business's raison d'etra, namely the supply of innovatory products.

The Chairman's conceptual talents described by one colleague as "a gleam in his eye" are acknowledged as vital to the Company's continuing prosperity by key executives. Although (as Table 1A shows) the majority of respondents accept product policy decisions are taken at the bi-monthly Divisional Board Meeting, strong reliance is still placed on his ability to interpret world scenarios and lead without leading.

CASE STUDY 'A' TABLE: 1A

QUESTION	ANSWERS	EXECUTIVE 1	DESIGN + ENGINEER 1	2	3	PRODUCTION 1	2
WHERE IS PRODUCT POLICY FORMULATED	Divisional Board level, bi-monthly meeting.	•		•	•	•	•
	Chairman, leads without leading. Flair, able to foresee.	•	•			•	•
	Minimum of data, keeps things close to chest.		•				•
	Consultation, but Chairman decides.		•			•	
	Sales Director - Managers strong input, often after event.			•		•	
	Casual conversation, sketches, back of envelope, exect.wall					•	
	Relaxed management style encourages ext. contact all levels		•		•	•	•
	Design represented by Engineering Director.				•		
	Never called into debate.			•			•
HOW LONG DOES IT TAKE. NUMBER OF INDIVIDUALS	Eighteen months cycle.		•	•		•	•
	Three - six months gestation period.					•	
	Variable cycle period.		•				
	Project monitoring group. 8 - 12 strong.	•	•		•	•	
	Membership of monitoring group varies from proj. to proj.		•		•	•	
	The Chairman nearly always leads. Gleam in his eye.		•	•			
	Executive Committee. Chairman acts as external Consult.				•	•	
	Weekly meeting.				•		
	Don't know whether anybody else is involved.			•			
WHAT SORT OF INFORMATION IS PROVIDED	Design/Project Specification.	•		•			
	Chairman has powerful impact. Emanates from single source.			•			
	Sales & Engineering consulted.	•	•	•			
	External sources feedback. Nose for industry on experience	•	•				
	No consultation. Minimum of information.						•
	Casual contact network. Data rarely formalised.	•	•			•	
	Natural desire to be innovative. Brain storming.				•	•	
LIST THE THREE FACTORS WHICH INFLUENCE PRODUCT SUCCESS OR FAILURE	SUCCESS						
	Links with components suppliers	•					•
	Competitive in terms of cost, value for money, performance.		•	•	•		•
	Single mindedness.					•	
	Simplicity					•	
	Leading through innovation, ahead of competitors.	•	•	•	•	•	
	After sales service.		•				
	FAILURE						
	Uncompetitive in terms of cost, value for money, performance.		•		•		•
	Committee design, sales dominated, ineffective selling.			•	•	•	
	Over engineered.					•	
	Lack of market research.	•	•	•		•	
	Poor manufacture. Too rapid development.		•	•	•		
DO YOU PROMOTE INNOVATION WITHIN BUSINESS	No formal methods. No policy for encouragement.	•				•	
	Informal contact through casual discussion.		•			•	
	The problem is to spot emerging ideas.			•			
	On occasions bottom-up ideas are incorporated.	•		•			
	Innovative atmosphere. Staff expected to switch jobs.		•			•	
	Dialogue with Works Manager - then Supervisors.			•			
HOW IS BUSINESS COPING WITH CHANGE	No formal policy		•	•		•	
	Majority learn through on the job experience.					•	
	Unsatisfactory		•				

PRODUCT POLICY AND DEVELOPMENT

The new product development programme is no exception, leaning heavily on a design/technological leap to overtake competitors who have recently found themselves in a position to threaten the Company's market.

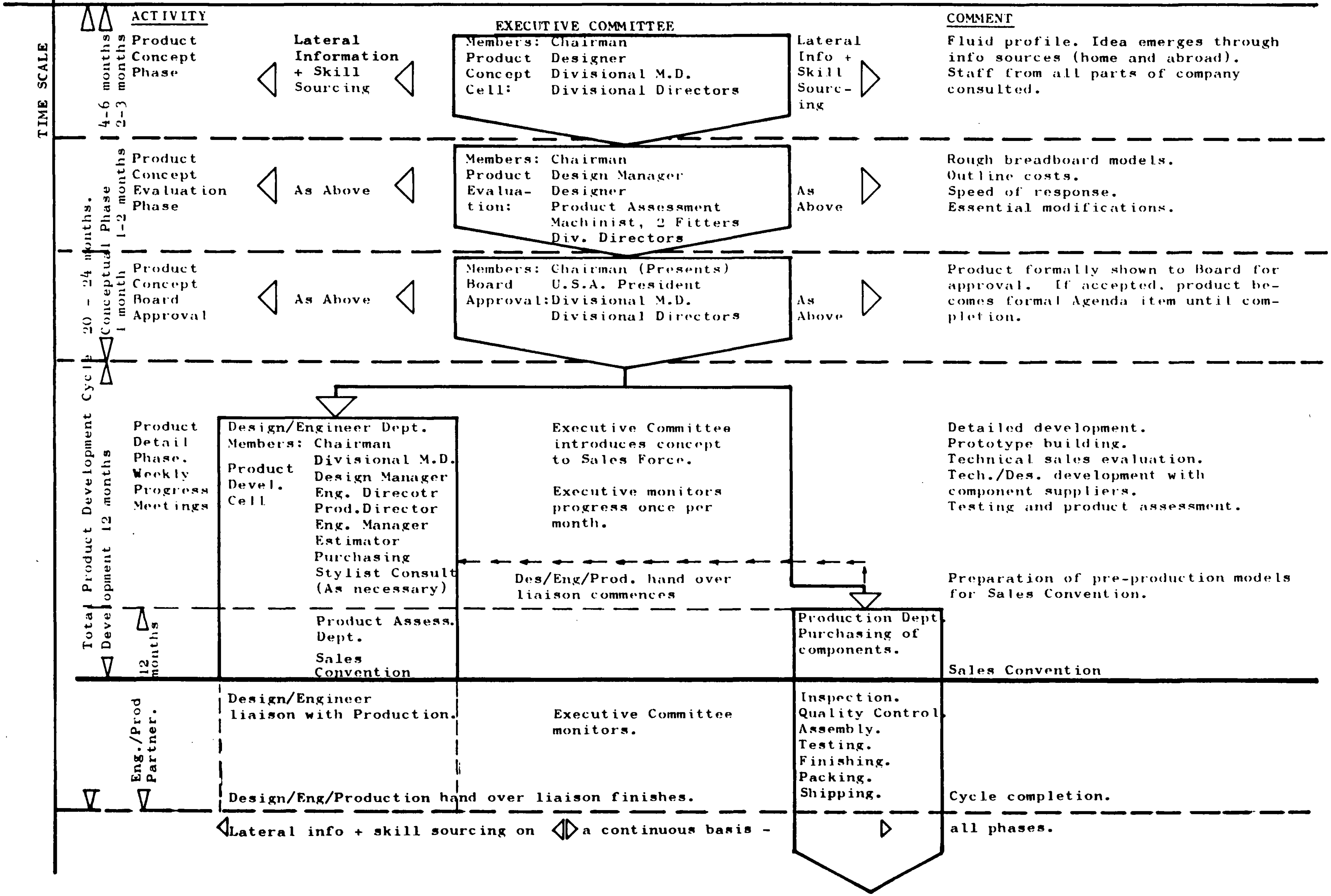
<u>Product Development - Structure and Resources</u>

The product development cycle represents a major investment by the Company and usually occupies a minimum two year period, reinforced by a further twelve months of design and production liaizon during introduction to the market. It commences with an outline idea which gradually crystallizes into a product view via casual and regular dialogue between the Chairman, Directors or senior members of staff; concepts being tested against data culled from the Company's world wide sales offices and customer or sub-contractor feed back. The structure is informal and encourages unorthodox methods of communication, sketches on the back of envelopes, the office wall or other media, anything to start the germination of ideas. Irrespective of the strong lead given by the Chairman, the business's informal relationships between different levels of staff allow for participation on terms of relative equallity, giving as one production interviewee put it "an element of fun". Contact at this and the two subsequent phases has a strong lateral flavour, though it mainly operates at director and senior management levels.

Figure 10 illustrates the general profile of the cycle, the first three phases normally occupying a 4 - 6 month gestation period. Here the Chairman takes a deep personal interest, moving the project past a series of checkpoints which can be classified as conceptual, evaluation and testing for viability. All have certain

FIGURE 10

THE PRODUCT DEVELOPMENT CYCLE - SCHEMATIC STRUCTURE



characteristics, the project team membership adjusting to the requirements of each stage.

Evaluation normally absorbs the largest input varying from eight to twelve staff, including on what one occasion was described as an innovative machinist and two fitters for the construction of breadboard models. During these initial phases production staff have minimal contact other than the Director. The last checkpoint, testing for viability, sees the Chairman present the product's case to the Divisional Board and if approved, moving on to the agenda until completion.

The Development programme now takes on a wider remit encapsulating sales comment and the technical problem solving resources available from within or outside the Company. Figure 10 graphically demonstrates the strength of complexity, demanding in the opinion of one engineer, " a degree of creativity equal to that experienced at the outset ", or as explained by another member of staff:

" During this phase the Design Engineering Department comes into its own. The Chairman lacks enthusiasm for detail, preferring to concentrate upon the conceptual direction of the solution. Engineering however, are able to contribute the detailed thinking so as to ensure a practical and cost effective result. The juxtaposition of these streams catalyses a second and equally important creative period in the product's birth cycle. I believe this factor, when coupled to the business's relaxed management style inadvertently stimulates a problem solving atmosphere which can be termed as innovative ".

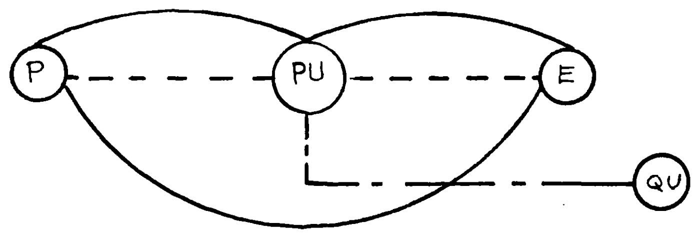
The fourth and aptly termed product detail phase occupies a central and crucial position, taking anything from 12 to 18 months and as many attendant skills to complete.(See Figure 10). A superficial view indicates an intersectional activity network of considerable complexity, but in essence it is relatively simple. The balance of the decision making process rotates around three primary zones, design engineering, external suppliers and the in-house purchasing facility, the leader role passing from one to another as demanded by the Product's emerging development characteristics.

With the business's heavy reliance upon the confidence of sub-contractors and purchasing's significant role in the maintenance of such confidence, it was therefore surprising to learn that roughly 60% of the cycle was completed before they entered the arena. The current product programme has attempted to rectify this deficiency by seconding right from the start an estimator from the purchasing section to design engineering. Despite such an innovatory move, a comprehension gap between the two was clearly visible, design engineering believing purchasing have difficulty in understanding the design ethic, whilst they bemoaned engineering's failure to work with suitable or competitive suppliers. Each side's view of the others shortcomings are underlined by opinions expressed during the research.

Design Engineering: "Up to this point the design engineers have been liaizing directly with potential suppliers. Once Production become involved costs tend to escalate and are difficult to control. This represents a dangerous point in the development cycle. In my experience sales and production staff tend to be conservative and find it difficult to comprehend what is not already known".

Production: "Purchasing occupy a central position, working with Engineering, Quality Control and Production staff — See Figure 11 below. The new development programme has recognized the importance of our function, hence the secondment of an estimator for closer liaizon with Engineering Design. Often component estimates obtained by the engineers are found to be too high and because of our late entry and the need to meet the market launch date it is virtually impossible to find alternatives in time. Only when the product has been in production for approximately 18 months can we initiate unit cost savings".

Figure 11.



However, these attitudes may be more a reflection of frustration than actual disagreement. They need to be viewed alongside the findings of a limited inquiry designed to ascertain the level of comprehension between the sectors of the product cycle. The results are catalogued under Table 1A . Here consensus is reached on a number of key topics, cycle time, meeting structure, the role of the Chairman, market competitiveness and the Company's management style.
But other issues such as inter-departmental liaizon, provision of information, links with component suppliers or factors contributing to success, do record differences of opinion which can, depending upon interpretation be connected with earlier quoted views.

The tendency for function separation is given a further twist by comment from one of the senior engineers on the up and coming generation:

"Too many young engineers have worked in design engineering environments that are geographically separated from the production activity. This trend was particularly fashionable in the late sixties and early seventies, but today's financial circumstances are causing a reappraisal. Design and production engineers need to be more closely integrated. It is essential they comprehend each others interaction".

Finally, it is interesting to also note the slight feeling of regret felt by the Design and Production senior managers when it comes to the lack of consultation over product policy.

Despite the existence of a project monitoring system, it can be argued the extended nature of communications at this and the remaining parts of the cycle are particularly vulnerable to disruption, requiring sensitive interdepartmental co-operation for the deadlines imposed by market launch dates not to prove embarrassing. The composition of the development team's structural balance is therefore a critical factor if the design manufacture interface is to respond effectively and not degenerate into a grey zone and give those engaged the chance to indulge in the traditional sport of passing the buck. The move to second an estimator to Design is partial recognition of the problem, perhaps the process should also have been reversed, Design to Purchasing!

However, to sustain a close and two way design and production working relationship is hard work, requiring from participants a degree of mutual respect and support by the adoption of a common language to classify product success and failure characteristics. With a view to ascertaining existing perception variables, a small number of design engineering and production staff were asked to take part in a simple inquiry. The results are summarized under Tables 1B and 1C respectively.

The most important aspect is the surprisingly high level of unanimity from respondents on both sides to questions directed towards identifying criteria which encourage product success or failure. Top of the list comes good/ poor design described by some to possess qualities that embrace a definitive function, a natural extension of known technology and innovation or conversely as over-sophisticated and showing a lack of Company commitment. Following closely behind is the competitive/uncompetitive axis in terms of cost, value for money and performance, the majority citing them all as important with well planned or insufficient market research bringing up the rear.
On the other hand when these sentiments are placed against responses given to subsequent questions (Table 1B), an in-consistent pattern becomes visible, especially under the success mode. Both parties can be faulted. For instance, the product initially is felt to be competitive, but examination of the answers given to later topics, product drawbacks or competitor strengths and weaknesses tends to supplant this certainty by a measure of doubt. The fact that both design and production personnel can readily acknowledge shortcomings in the Product's specification or an absence of competitor analysis is a disquietening snapshot, suggesting individuals have a poor comprehension of the external environment within which the business is operating. Table 1C only goes to reinforce this concern, particularly under comment recorded against the long term corporate view.

CASE STUDY 'A'

TABLE: 1B

QUESTION	PRODUCT SUCCESS - ANSWERS	DES.		PROD		PRODUCT FAILURE - ANSWERS	DES.		PROD		
WHY IS THE PRODUCT	DEFINITIVE FUNCTION	•				INSUFFICIENT MARKET RESEARCH	•		•	•	
SUCCESSFUL/FAILURE?	NATURAL EXTENSION OF COMPANY TECHNOLOGY	•	•		•	UNCOMPETITIVE - COST + PERFORMANCE	•		•	•	
	EASE OF MANUFACTURE, INSTALLATION SIMPLE	•	•	•		POOR DESIGN - OVER SOPHISTICATED	•	•	•	•	
	COMPETITIVE COST, GOOD VALUE	•	•	•	•	INADEQUATE PLANNING+MARKETING+SALES			•	•	
	PERSONAL COMMITMENT. COMPANY IDENTIFICATION		•	•		LACK OF EQUIPMENT, BY COMPANY	•		•	•	
	INNOVATIVE, WELL DESIGNED			•	•	CONFLICTING MARKET DEMANDS		•			
	GOOD QUALITY, RELIABLE, WELL DETAILED				•	SALES DOMINATED		•			
	EFFECTIVE MARKETING			•		TECHNICAL DIFFICULTIES	•	•			
WAS THERE A BRIEF?	THREE LINE TELEX	•	•			DETAILED BUT CONFLICTING		•	•		
	NO CHANGE SINCE BRIEF	•				BRAIN-CHILD OF TECHNICAL DIRECTOR			•		
	DON'T KNOW				•	SOLUTION LOOKING FOR A PROBLEM			•		
WHICH SINGLE	A SINGLE-MINDED APPROACH	•				OVER-SPECIFICATION		•			
DECISION LED	THE ENCAPSULATION OF COMPONENTS		•			TO INTRODUCE PRODUCT BEFORE PROVING VIABILITY			•		
TO SUCCESS/FAILURE?	RESISTANCE TO THE ENVIRONMENT		•			UNABLE TO RESIST ATTRACTION OF CONCEPT			•		
	DON'T KNOW				•						
MAJOR PRODUCT	ENVIRONMENTAL. SPECIFICATION REQUIRES 25° AT 10° DIFF.	•				TOO COMPLICATED WITH COMPARABLE PRODUCTS		•	•		
DRAWBACKS	UNDERPOWERED	•	•			TOO MANY COMPONENTS		•	•		
	DIFFICULT TO MEET PRICE CONSTRAINTS		•			EXPENSIVE TOOLING		•			
	UNCOMPETITIVE				•	LONG INTRODUCTORY SELLING PERIOD		•	•		
	TOO MANY MOVING PARTS				•						
KEY COMPETITORS	COMPETITOR PRODS HAVE NOT BEEN ANALYSED	•				SIMPLICITY		•			
STRENGTHS AND	NOT RELEVANT, NOT SURE		•		•	WELL ENGINEERED, RELIABLE		•			
WEAKNESSES	MAJOR COMPETITOR - GERMANY				•	GOOD LITERATURE		•			
	BETTER VALUE				•	KEY COMPETITORS NOT MARKET SIMILAR			•		
	WELL DESIGNED				•	USER CONVENIENCE FAULTS		•			
WHAT ACTION IS	NOT RELEVANT, NONE	•	•			MANY LESSONS ARE BEING INCORPORATED					
BEING TAKEN TO	NEW PRODUCT				•	INTO NEW PRODUCT RANGE		•			
CAPITALIZE ON						NO ACTION			•		
COMPETITORS'											
WEAKNESSES?											

PRODUCT SUCCESS AND FAILURE FACTORS

CASE STUDY 'A' TABLE: 1C

QUESTION		ANSWERS	SUCCESS: 1 DES +	SUCCESS: 2 ENGINEER	SUCCESS: 1 PROD.	FAILURE: 1 ENGINEER	FAILURE: 1 PROD.	
HOW DOES THE PRODUCT REFLECT THE COMPANY'S	PUBLIC IMAGE	Innovative.		•	•			
		Good Design.			•			
		Reliability.			•			
		Technical Submission.		•				
		Don't Know.	•					
		Damaged Customer Relations.				•		
		Adversely.					•	
	MARKET POSITION	Initially captured market. now too costly.			•			
		Competitors offer better value.			•			
		Imaginative and economic solution.		•				
		Not applicable.	•					
		Launched too late.				•		
		Created a lack of customer confidence.				•	•	
		Sent back, on third occasion customers did not want to know.					•	
	INNOVATIVE CAPABILITY	Highly innovative, when introduced.			•			
		Competitors have now overtaken.			•			
		Built upon known technology.	•	•				
		Over sophisticated. not easy to set.				•	•	
		Too clever.					•	
	MANUFACTURING RESOURCE	Still good. easy assembly which has helped to sustain market position.			•			
		Will maximise economic production run.	•	•				
		Good profit return.	•	•				
		Over extended capability of suppliers.				•	•	
		Rushed introduction.					•	
		Lost confidence in engineer quality.				•		
	LONG TERM CORPORATE VIEW	New range is logical development.			•			
		Company lacks continuous market research and product development programme.		•	•			
		Product came about by accident.		•				
		Not applicable.	•					
		None, but some lessons have been incorporated into new developments.			•			
		Acted as catalyst by bringing back under Chairman leadership.					•	

Notwithstanding these reservations, empirical observation of the recorded comments does portray a strong and genuine interest by both sides of the design and manufacturing interface in the product. A cross sectional analysis of the views expressed demonstrates a measure of agreement which if built upon would most probably enable the time taken by the product development cycle to be considerably reduced. The question then has to be posed, if Design and Production are able to harbour such a level of agreement on product performance criteria, why do they operate in a vacuum and have so little lateral contact?

Case Study 'B'

Historical Background

The Company belongs to a Group who manufacture a comprehensive range of high technology products for the civil and defence market sectors. Originally founded in 1947 and consolidated in 1967 by joint ownership with an American partner, the business has grown into a U.K. and European market leader that generates today a turnover of £30 million plus per annum.

Initially the business was created as a wholly owned subsidiary to exploit the potential of the parent's cabin pressurization valves. It was staffed by a small in-house design team with access to technical license agreements negotiated with a number of U.S.A. companies in the same field. As the subsidiary grew, the association with one of the U.S.A. licensees became particularly sympathetic, leading to the founding in 1967 of the now jointly owned Anglo/American enterprise, the British retaining a 52% majority holding.

From such a base, vigorous growth has been the norm, encouraged by new product development and where appropriate, the acquisition of supportive technologies whether they be generated in-house or by the purchase of other related businesses. In addition, the financial and technological resources of the joint holding company has permitted a variety of high technology product areas to become established, namely hydraulics, pneumatics, life support equipment, electronics and filtration.

To service these main product groupings, a collection of technology centres known as pneumo-mechanical, fluid-mechanical, electro-mechanical, prime movers, foundry and filtration have been formed. The breadth of the technology encapsulated by these centres is of increasing sophistication, which is pushing the centralized headquarters structure towards a more divisional matrix for servicing the specialist needs of each market sector.

A crucial stage has now been reached. The Company has grown quickly and currently contributes substantially to the turnover and profits of the parent group. However many of the traditional trading areas are experiencing a downturn or have plateaued due to either recessional factors or a license agreement prohibiting entry into the lucrative U.S.A. market. Success has therefore brought its own problems, sharpening the internal debate on the shape of alternative product diversification options to counter declining markets. The move towards a divisionalized matrix structure of "profit responsible" management functions is but one sign of the response to a changing external environment.

Manufacturing Resource

The Company has an extensive and highly efficient production capability, incorporating computerized control of machine tools as well as quality control and inspection systems that are able to meet the stringent quality assurance standards set by customers. The range of available manufacturing resources are tightly controlled permitting finished products to be traced at any stage during the production process, from the point of entry as raw material through to completion.

To manage such a diverse collection of making resources, computerized production methods have been introduced to improve the control of work in progress. A specialist CNC machine centre has also been built which allows a range of 1500 high technology components to be economically produced in batch quantities as low as 25 in number. As one of the senior managers remarked, "the business's production situation can be likened to a 'High Tech' jobbing shop".

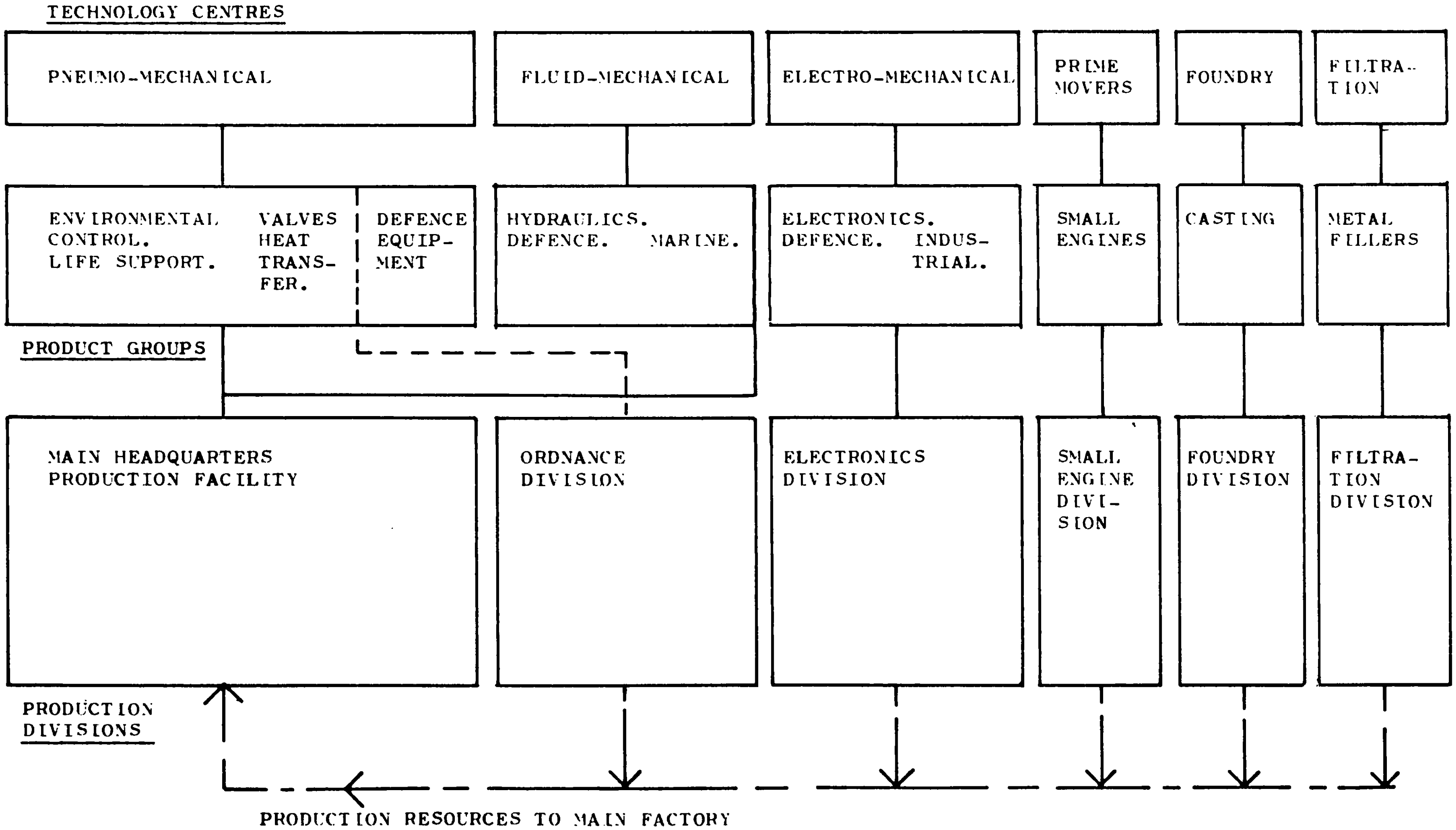
The production capacity consists of a main facility located on the headquarters site where major support services such as research, design and development are also housed, plus the specialist divisions of electronics, filtration, foundry and ordnance, all of whom are in close geographical proximity.

Although the divisions function as semi-autonomous units on a daily management basis, they still retain organizational links with the head office, co-operating and sharing capacity between themselves and the main manufacturing unit as and when appropriate. Each division has a General Manager and a supporting Executive Director, the latter facilitating a line of communication to the Main Board. Consequently the production resource structure can be described as hierarchial, the divisions managing specialist technologies, but subject to strategic production planning decisions from the centre. Figure 12 illustrates the relationship of the technology centres to the product groups and the divisional production resources.

CASE STUDY 'B'

FIGURE 12

RELATIONSHIP OF TECHNOLOGY CENTRES TO PRODUCT GROUP



The overall manufacturing philosophy appears to underwrite the principle of self-sufficiency, the development of new making processes emerging as a result of high technology product demands. Sub-contractors are used fairly extensively, but usually more in response to internal production bottle-necks or as a means of reducing the cost of components. Manufacturing's remit tends to be viewed as reacting to initiatives taken elsewhere, or as put by one executive "no point in involving manufacturing in meetings to decide what not to make".

Design and Technology

As already intimated, the Company has grown and now offers a performance of rising turnover and profits to the parent, whose own results on comparable criteria are unable to match. The products manufactured by all the companies within the Group fall into a high technology category and consequently the characteristics which have enabled the Group's protege to outperform the other more established members are now receiving closer attention.

During the inquiry period which included discussion with individuals and attendance at Seminars, a number of minor factors did come to light. Singly they warrant no more than a passing glance, but when listed collectively can be adjudged to give a directional clue:

- The Company's Managing Director started his career as a Trade Apprentice in the U.K. parent of the Holding Company before qualifying through a scholarship as a Design Engineer in the mechanical sciences.

- The whole culture of the business has an entrepreneurial flavour, rotating around design and technical innovation.

- Research and development is a key function involving approximately 15% of personnel employed.

- An inter-disciplinary team structure for problem solving tasks has been established.

- A do-it-yourself approach to the design and making of new production equipment.

- In-house implementation of new production systems built upon existing trade skills and experience.

Together the attitudes expressed do no more than confirm the reliance placed on Research and Development as a continuing source for future success. As found in Case Study 'A', the Managing Director took a strong personal interest in new product initiatives, a situation recognized by all the respondents seen during the study.

Product Development - Structure and Resources

Because of the business's high technology remit, the cycle tends to be long, complex and requiring expertise from a large number of individuals. It has been known for some projects to extend beyond a decade, but on average the timescale hovers around 2 - 3 years.

Until approximately two years ago, the majority of new product assignments resulted from customer initiatives. Acceptance for manufacture was often governed by the degree of potential gain to the level of the Company's high technology base. Whilst this assisted to generate the sought after entrepreneurial lead, it also tended to result in the misdirection of resources and cause a conflict in perceived priorities. The situation was recognised and led to the appointment of a Main Board Marketing Director and the creation of a New Products Enquiries Committee, chaired by a Business Planning Manager. These two steps, inconjunction with other supportive adjustments has encouraged the introduction of a more rational appraisel system for adjudicating the competing merits of product proposals submitted.

New product ventures commence life in one of three categories:

- New Business Enquiries.
- Private Venture Initiatives.
- Externally funded Research and Development.

The two latter categories form a minority of new product commitments at any one time. Private venture initiatives are nearly always sponsored from the engineering department. External research and development can be very profitable, so much so that an engineer waspishly proposed the section could make a better contribution to Company results if it withdrew totally from the manufacturing interface!. However, it is in the New Business Enquiries sector where the bedrock of the product development programme lies.

Customer requests not falling into a repeat business slot are initially screened by the New Business Enquiries Committee, the membership of which is drawn from the Marketing, Commercial and Engineering departments. Each proposal is individually examined against three fundamnetal criteria:

- Does it fall into existing product experience?
- How complex, how much investment in development time, capital equipment, etc. ?
- Will it be profitable?

Initial scrutiny is undertaken on a yes/no weighting and if positive, a detailed technical submission and estimate is prepared for the customer. Such a decision triggers into action a well established procedure, which can be summarized as follows:

- Engineering Group Manager appoints a Project Engineer.
- Project Engineer prepares a design/technical prospectus, liaising with other specialists.
- Project Engineer hands over technial concept to Commercial Department for preparation of final prospectus estimate.
- Manufacturing views are sought in respect of hardware and tool costs.
- Proposal submitted to customer.
- Upon acceptance, a two part internal works order is raised by the Commercial Department and sent to Engineering and Manufacture.

It is estimated this phase can take anything up to 12 months to close.

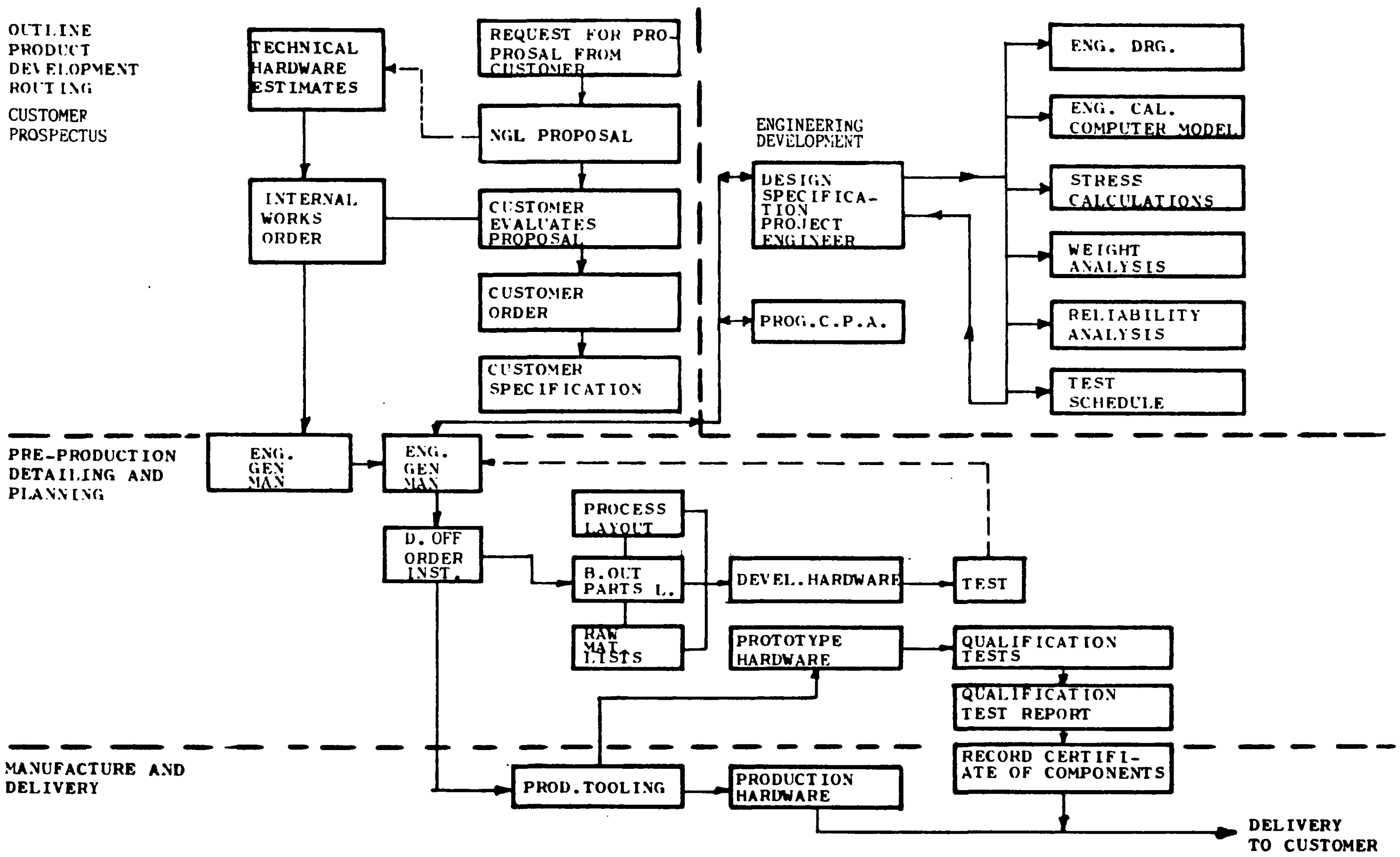
The development cycle now broadens the catchment area to include manufacturing, who, other than the casual contact previously noted, are for the first time being advised of the enterprise's commitment. Figure 13 shows the routing as perceived by an n n engineer; Figure 14 is taken from the issued Control Systems Manual and gives a Production Control view of the expected level of interdepartmental co-operation. Both have made strenuous efforts to projectan overview of the cycle as seen by them, but as would be expected, the listed activity headings are quite different. What is even more fascinating, is the interface of Manufacture Engineering with other sections - Figure 15. Not only do the graphics vary from those adopted by Production Control, but the depth of data presented is of quite another order. The lack of consistency is even more puzzling when it is realized both these areas come under the umbrella of the manufacturing division.

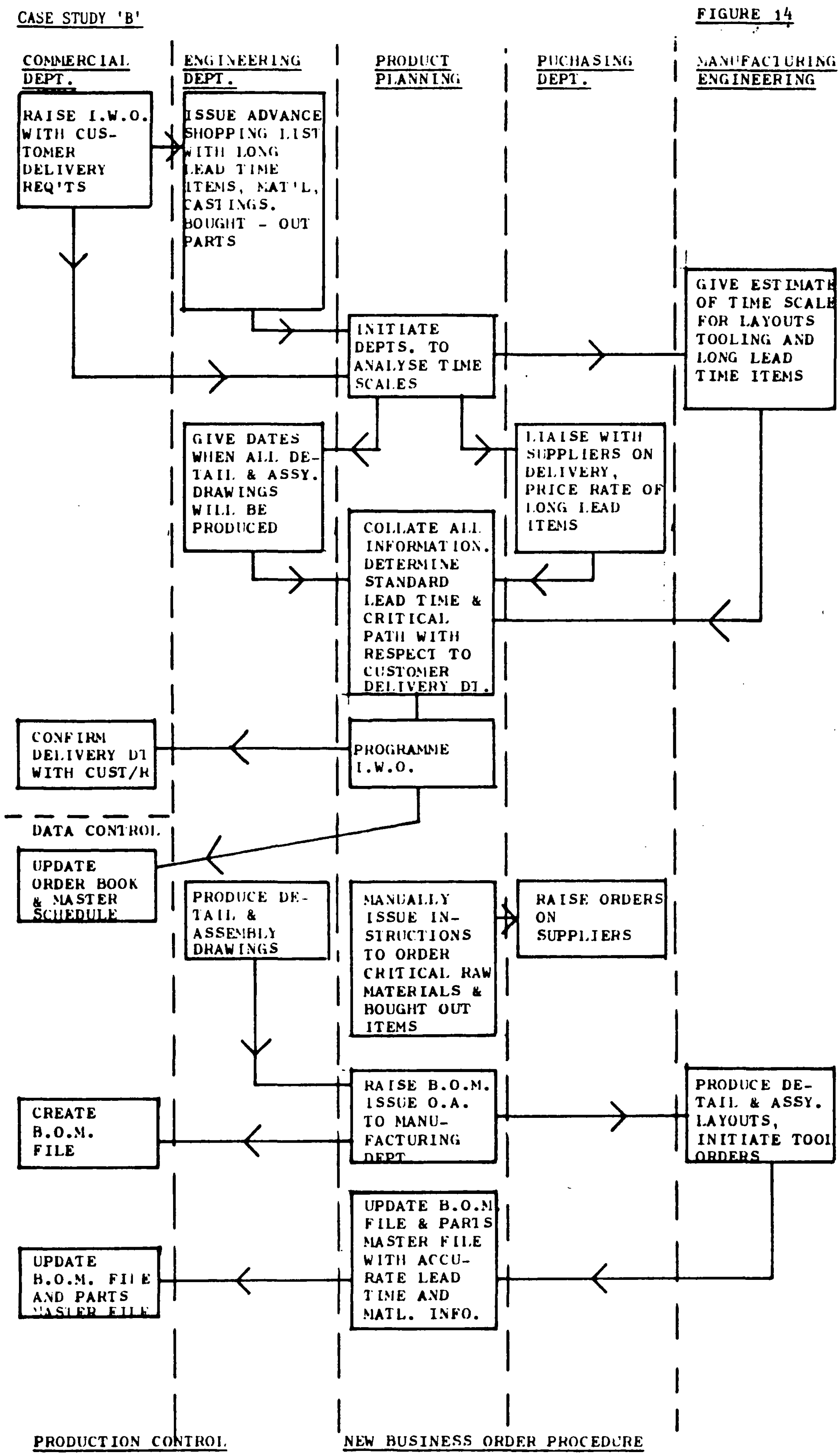
However, in the last analysis, Figures 13, 14 and 15 demonstrate the existance of an overlapping communication network between the sectors. Further the Company through its Control Systems Manual has established well thought out procedures for each sector to monitor the implementation of new order decisions. In consequence, it was therefore

CASE STUDY 'B'

NEW BUSINESS ENQUIRIES

FIGURE 13

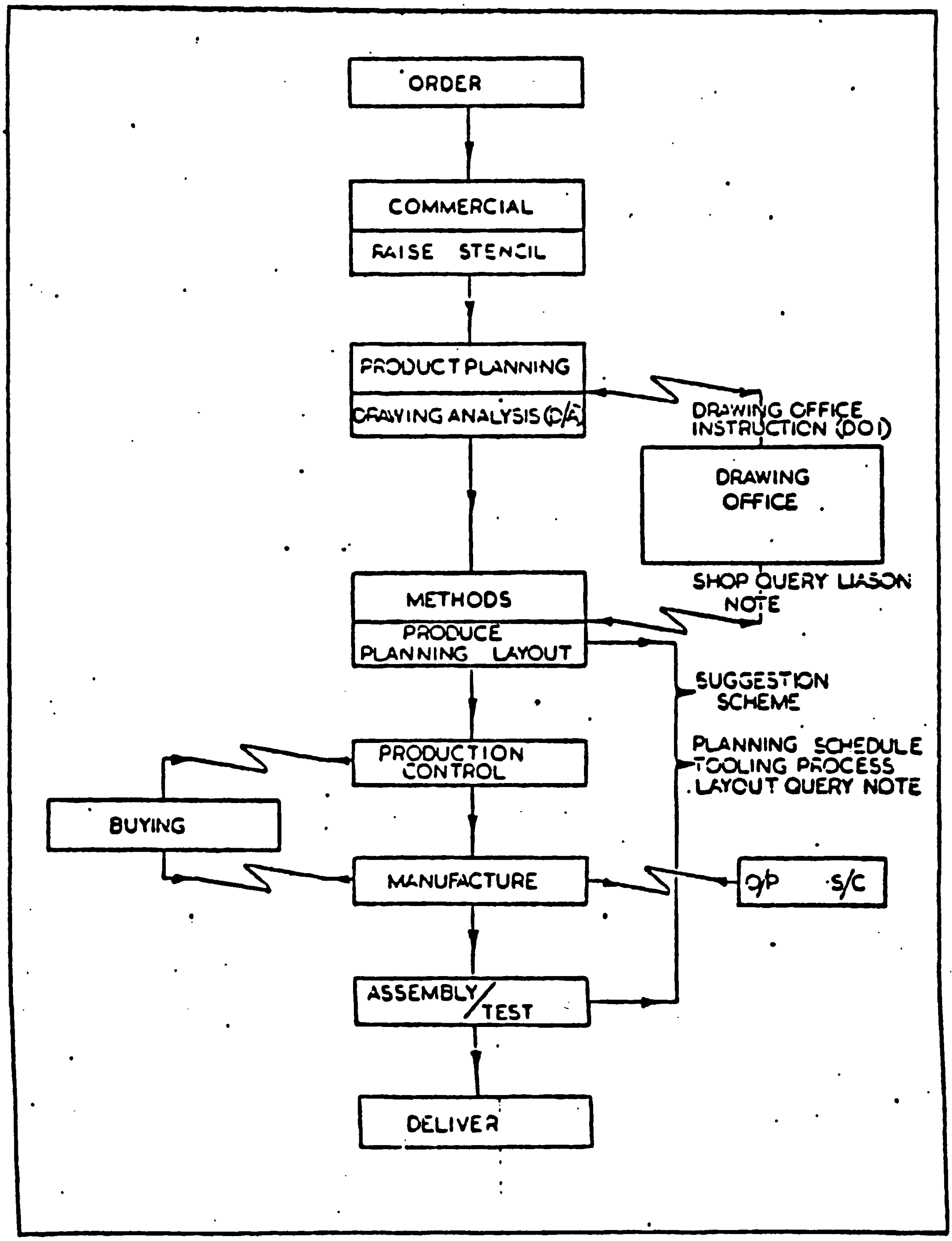



CASE STUDY 'B'
FIGURE 14
COMMERCIAL DEPT.
ENGINEERING DEPT.
PRODUCT PLANNING
PURCHASING DEPT.
MANUFACTURING ENGINEERING
RAISE I.W.O. WITH CUSTOMER DELIVERY REQ'TS
ISSUE ADVANCE SHOPPING LIST WITH LONG LEAD TIME ITEMS, MAT'L, CASTINGS, BOUGHT - OUT PARTS
GIVE ESTIMATE OF TIME SCALE FOR LAYOUTS TOOLING AND LONG LEAD TIME ITEMS
INITIATE DEPTS. TO ANALYSE TIME SCALES
GIVE DATES WHEN ALL DETAIL & ASSY. DRAWINGS WILL BE PRODUCED
LIAISE WITH SUPPLIERS ON DELIVERY, PRICE RATE OF LONG LEAD ITEMS
COLLATE ALL INFORMATION. DETERMINE STANDARD LEAD TIME & CRITICAL PATH WITH RESPECT TO CUSTOMER DELIVERY DT.
CONFIRM DELIVERY DT WITH CUST/R
PROGRAMME I.W.O.
DATA CONTROL
UPDATE ORDER BOOK & MASTER SCHEDULE
PRODUCE DETAIL & ASSEMBLY DRAWINGS
MANUALLY ISSUE INSTRUCTIONS TO ORDER CRITICAL RAW MATERIALS & BOUGHT OUT ITEMS
RAISE ORDERS ON SUPPLIERS
RAISE B.O.M. ISSUE O.A. TO MANUFACTURING DEPT.
PRODUCE DETAIL & ASSY. LAYOUTS, INITIATE TOOL ORDERS
CREATE B.O.M. FILE
UPDATE B.O.M. FILE & PARTS MASTER FILE WITH ACCURATE LEAD TIME AND MATL. INFO.
UPDATE B.O.M. FILE AND PARTS MASTER FILE
PRODUCTION CONTROL
NEW BUSINESS ORDER PROCEDURE

CASE STUDY 'B'

FIGURE 15

INTERFACE OF MANUFACTURING ENGINEERING WITH OTHER ACTIVITIES



surprising to discover in such a detailed document no reference to the product development cycle as an across the board activity. Why should this be the case?

As previously noted, intersectional communications tend to be irregular at the beginning of a new order cycle. Views culled from respondents lend a measure of support to this observation, particularly with regard to manufacturing's relationship to the engineering/commercial department axis. Whether the distancing of manufacture is consciously perpetrated or dialogue is just believed to be unnecessary is hard to determine, though comments expressed and listed below do give some credence to the latter conjecture:

Commercial - "Manufacturing become involved through providing estimates for hardware and tooling, but liaison with this sector is very limited".
"It has been found Project Engineers tend not be cost orientated".

Engineering - "In addition, design schemes are submitted to Manufacturing for estimating hardware and tooling costs. A void may exist between design engineering and manufacturing".
There are no formal procedures for encouraging the promotion of an innovative design/manufacturing interface. Design engineers tend to be critical of manufacturing engineers and vice-versa".

Engineering - "Informal channels of communication are kept open by individuals, but this purely depends on personal initiative and goodwill".

Manufacturing- "There is no manufacturing representative on the New Product Enquiries Committee".

"People outside manufacturing tend to believe there is infinite capacity".

"Generally manufacturing is approached on the basis - can you cope with it?".

"The relationship between manufacturing and design/engineering during the product development phase is on the letter box principle, design perceiving a problem and coming to discuss with us. It is rarely the other way round".

"Manufacturing do become involved in determining project timescales, plus sometimes acting in an advisory role. However, in the end, design tell us what is required and we just implement it".

Of equal importance is the degree of recognition or otherwise achieved by the key functions, commercial, engineering and manufacture in determining those factors within the current cycle that can assist or hinder successful completion. To gauge opinion, a limited enquiry was conducted with staff from the three areas and the results are tabulated in Table 2A. Accord is reached on a number of aspects:

- The absence of and need for a product policy making body.
- The reactive as opposed to a proactive stance to customer enquiries.
- Approval of the Marketing Director appointment.
- Recognition of the recently formed New Business Enquiries Committee.
- Limited manufacturing liaison.
- The tendency to develop products in isolation from each other.
- The important role of the Project Engineer.
- Product failure caused by over optimism and unproven design and production processes.
- Staff development.

What also stands out is the predictable nature of the registered blind spots. For instance product policy is seen either as customer specific or technological excellence, the number sitting on the New Business Enquiries Committee varies, project initiatives tend to originate from the respondent's department and the promotion of innovation is recognized by manufacturing as a relatively structured activity, whereas the other two sectors hardly give it a glance.

As observed in Case Study 'A' communications during the latter stages of the product cycle assume a different shape, moving from a relatively vertical format to a more lateral configuration. Figure 13

CASE STUDY 'B' TABLE: 2A

PRODUCT POLICY AND DEVELOPMENT

QUESTION	ANSWERS	Commercial	1 Engineer-	2 ing	1 Manufact.
WHERE IS PRODUCT POLICY FORMULATED?	No formal body.	•	•	•	•
	Enterprise is reactive to opportunities.	•	•	•	•
	Tends to misdirect resources.		•		
	Company purchaser orientated.	•			
	Policy to encourage high tech projects.				•
	Hopeful change because of Market Director appointment.	•	•		•
	Each day its own.			•	
HOW LONG DOES IT TAKE? NUMBER OF INDIVIDUALS.	Due to wide range, impossible to give average lead time.	•	•	•	•
	New business enquiries mainly from existing customers.	•	•		•
	New product enquiries:	•	•	•	•
	Committee formed - Members 5			•	
	4	•	•		
	3				•
	Liaison with manufacturing limited.	•	•		
	No manufacturing representative - not necessary to join				
	in decision what not to make.				•
	Market section now handle new enquiries.	•			
	Spend 25% of time on sales - Too much.			•	
	Traditional for Engineers to spend time on selling.		•	•	
	Raporte between Engineering/Sales staff poor. Marketing appointment		•	•	
	may change this balance.				
WHAT SORT OF INFORMATION IS PROVIDED?	No written project acceptance criteria.	•	•		
	Learnt by experience and consulting superiors.	•			
	Customer approached for further details.		•	•	
	Each project is dealt with separately.	•	•	•	•
	No formal data.				•
	Existing info collation not rational in terms of product policy.	•	•		
	Project Engineer prepares technical proposal.	•	•	•	•
	Commercial Dept. co-ordinates and undertakes cost estimate.	•	•	•	
	Commercial Dept. initiates.	•			
	Manufacturing estimate for tooling/hardware only.	•	•		
	Customer information may be prepared by Engineer or Contracts Manager.				•
	Void may exist between Design/Engineering and Manufacturing.	•	•		
	Generally Manufacturing are approached on the basis of:				
	'Can you cope with it'.				•
LIST THE THREE FACTORS WHICH INFLUENCE PRODUCT SUCCESS OR FAILURE	Success: Customer Specification being met.	•	•		
	Completion within cost.	•	•		
	Delivery on time.		•		
	Good planning.				•
	Orientated towards front end of manufacturing.				•
	Failure: Insufficient market research.		•		
	Over-optimism, hunches.	•	•		•
	Over-stretching technical know-how and skills.		•		•
	Missing cost targets.	•			•
	Poor after sales service.				•
	No customer liaison.	•			
	If you can draw it, we can make it.				•
DO YOU PROMOTE INNOVATION WITHIN BUSINESS?	No formal machinery to encourage innovation.	•	•		
	Design and Manufacturing Engineers tend to be critical of each other.		•		
	Depends on personal initiatives.	•	•		
	Wide experience does assist to liaize.		•		
	Company Suggestion Scheme in production unit.				•
	Brainstorming sessions.				•
	Sub-Contractors can provide innovative links.				•
HOW IS BUSINESS COPING WITH CHANGE?	Creation of Senior Management Association.		•		
	Establishment of Works Council.		•		
	Management Development Programme.	•	•		•
	Do not know of any formal policy.	•			•

also indicates a similar trend as the product moves into the pre-production detailing phase, a period in the cycle which requires commitment from an ever increasing number of highly specialized personnel. This in turn places considerable pressure on the project engineer who is responsible for co-ordinating the problem solving effort of those involved. When the business's innovatory attitude is also taken into account, though again tending to function on a departmental basis, the need for a product development structure capable of encouraging a unity of purpose becomes important.

Unity of purpose as applied to innovation has been examined in organizational terms by Sheppard (46) who comments:
"The innovation producing organization must aim to provide an environment in which this kind of growth can occur. This means a climate in which members can view one another as resources, instead of competitive threats; a climate of openness and support in which differences can be confronted and worked through, and in which feed back on performance is a mutual responsibility among members so that all can learn to contribute more".

But here, the enterprise's product development cycle moves through an infrastructure of expertise managed on sectional lines, which can only, but, negate any effort to create a climate of mutual responsibility.

Further, it is suspected the constant seeking for and application of advanced technology solutions, may cause additional difficulties when sections engaged on the product cycle attempt to identify common product goals. To explore this aspect, respondents took part in a simple enquiry to clarify qualities believed to enhance a product's chance of success or failure. Tables 2B and 2C summarize the responses received.

A disturbingly wide range of differing views emerged. All party agreement is reached on topics such as good in-service performance, extension of proven technologies and rational design. However, opinions diverge dramatically when it comes to identifying characteristics which constitute a good or poor product. The most glaring revolve around the engineers concept of performance criteria, the product brief and cost effectiveness. In all these areas, commercial and manufacturing staff agreed to differ. Further inconsistencies can be seen from the answers given to subsequent questions, i.e. engineering believed a particular solution to be cost effective, but held manufacturing responsible for the uncompetitive result. Finally, ignorance of competitor market analysis suggests a poor appreciation of the trading environment.

The picture is confused and the sample too small to make a concise value judgement. The study has however, illustrated the important role of the communication dimension, a point stressed by T. Allen (1) when he says:

CASE STUDY 'B'   PRODUCT SUCCESS AND FAILURE FACTORS   TABLE 2B

QUESTION	ANSWERS	1. Commercial	1. Design/	2. Engineer	1. Manufacture
WHY IS THE PRODUCT A SUCCESS?	Market leader.				•
	Simple in concept.	•			
	Superior performance specification to competitors.		•	•	
	Capable of adaptation to meet new situations.		•	•	
	Well designed. Rational.	•	•	•	
	No loss of performance over previous design.		•	•	
	Small and light.		•	•	
	Consolidated high tech lead in design and manufacture.	•			•
	Extended known high tech state of the art.	•	•	•	
	Good in service performance.	•	•	•	•
	Good delivery.	•			
WAS THERE A BRIEF AND WAS IT MODIFIED?	Yes, there was a Design Brief.	•	•	•	•
	No, the manufactured product did not vary from the Brief.		•	•	
	Yes, the Brief was modified.	•			•
	Not known what methods adopted for interaction between Design and Manufacture.	•			
	The design specification was handed over on basis of correct theory.	•			
	Design failed to specify right level of tolerances.				•
	Manufacturing do sometimes become involved.				•
	In last analysis Design tell us what is required, we just implement it.				•
WHICH DECIS. LED TO SUCCESS	Cost effectiveness/value engineering.		•	•	
	In-service reliability.				•
	Early identification of design fault.	•			
	Simplified manufacture, component reduction.			•	
MAJOR PRODUCT DRAWBACKS.	Side load problems, major modifications needed.	•			
	Original performance specification incorrect.				•
	Complex casting proved impossible despite Design and outside expert assurances.				•
	Delivery delays.				•
	Still too costly - Manufacturing.		•	•	
	World-wide market, but no company support services.			•	
	Lack of market analysis.			•	
	Ambient temperature ceiling too low.		•		
	Unable to cope with fuel systems effectively.		•		
COMPETITORS SUCC.	Proven track record. However never seen competitor data.	•			
	Don't know, not sure competitor data is analysed.				•
	Cost competitive, large volume. World-wide market.			•	
	Good market research.		•		
COMPETITORS FAIL.	Don't know.	•			•
	Heavier, requiring more power, limited specification.		•	•	
WHAT ACTION TO CAPITALISE ON WEAK-NESSES?	Don't know.	•			•
	Mark III version development authorised.		•	•	

CASE STUDY 'B' TABLE: 2C

QUESTION		ANSWERS	1. Commercial Dep	1. Engineering	2.	1. Manufacture
HOW DOES THE PRODUCT REFLECT THE COMPANY'S	Public Image.	Demonstrated what is expected from Company.	•			
		Customers have said 'we know you have problems, but you make an effort				
		to resolve them.'				•
		Innovative.		•	•	
	Market Position.	Has broadened Company's market position.	•			
		Continuation of hi-tech lead.				•
		Reduced number of competitors.			•	
		Increased lead due to improved performance.		•		
	Innovative capability	Customer required Company to resolve problem.	•			
		Extended our capability.			•	•
		Encouraged us to extend the state of the art.		•		
	Manu-facturing resource.	Manufacturing technology was stretched.	•			•
		Improved competitiveness, but sub-contracting still needed.		•	•	
	Long term corporate view.	Don't know.	•	•		
		Emphasise on new manufacturing techniques linked to advanced design.				•
		Push hydraulic expertise.			•	

"The more diverse the training and experience of a Group's personnel, the more it can benefit from an open exchange of problems and ideas among its members. Inter-personal communication provides the essential link between a problem and the experience required to solve it".

Here we have some of the specified ingredients, but lack a structure to encourage groups of highly qualified, but individual members of staff to reach a common perception of the product cycle, whether it is from a commercial, engineering or manufacturing perspective.

CASE STUDY 'C'

HISTORICAL BACKGROUND

The group encompasses the second largest manufacturing capability of its kind in the world enjoying an annual turnover of over £500m. They specialize in the production of consumer products with a particularly strong stake in the under 20's market. Although other divisions form substantial parts of the total resource, the sector under review dominates. It has six factories located within a 30 mile radius of Headquarters, all of whom managed to collectively produce during 1982 approximately 7,716,000 units with a workforce of 2,195 people. (Source: Company Research Unit).

Despite the strength of the group's market position 1981 saw falls in sales value and production output of 8 and 14 percent respectively, reflecting only too clearly the twin pressures of world recession and rising import penetration of the U.K. market.

The latter has become a very serious issue for the whole industry and a major cause of its accelerated decline since 1966. The statistical data in the Design Council's 1982 report on the industry paints a depressing picture. In 1966 there were 760 manufacturing concerns, by 1980 there were 306 with a consequent fall in employment from approximately 116,000 to less than 60,000 persons by 1982.

The brunt of the decline has been borne by the smaller firms who have traditionally formed the bulk of employers in this highly fragmented industry. The year 1977 saw a total of 429 companies employing 100 or less, by 1981 the number had shrunk to 182, a decrease of 58 percent. Due to its size and already noted market strength, the group has not been so severely affected, though factory closures and redundancies have taken place over the past three years.

Irrespective of the fall in U.K. manufacturing capacity, consumer demand has remained relatively constant per head of population. Imports have clearly played an important part in encouraging consumption to remain roughly in equilibrium, accelerating in 1979 from a 46 percent base to 56 percent of the total market by 1982. This trend contains all the classic symptoms of a manufacturing sector in decline, commencing with consumer rejection of the home produced artifact, followed by falling demand and profits which in turn squeeze resources for new product development. The import entrepreneur observes the gap, establishes a cost lead bridgehead and quickly consolidates by product choice, quality and sophistication. It has been said by a member of the company "that when penetration reached the level of 60 percent in the U.S.A., the large volume home producers virtually gave up the fight".

During the 1960's the majority of imports came from the Far East, Eastern Europe and Third World countries, selling fundamentally on the basis of a price advantage, although in some instances offering styles not readily available from home producers.

The last 10 years has witnessed a change in this pattern, quality imports gradually taking a greater share. These have come from either Western Europe - Italy, Portugal, Spain and latterly France or South America, Brazil and Argentina being typical sources. Italy, having established itself during the 1970's as a quality manufacturer and possessing a flair for originality in design and technology has become the leading European importer to the U.K., so much so that in 1982 it accounted for 33% of total imports. (Source BFMF).

All three divisions have been affected, the deterioration in the children's sector being particularly marked as shown by Table 1 below:

Table 1

Imports of Children's Shoes to the U.K.

Type	1979	1982
Sandals	28%	34%
Shoes	7%	14%
Canvas	58%	65%
Trainers	43%	52%

Source: Divisional Market Plan Summer Seasonal 1984.

In terms of market share, penetration can be described as even more serious than the figures suggest, especially when the current declining demographic profile of the 0 - 15 age group is taken into account. However, the 0 - 3 years population has started to rise and will eventually lead to an overall growth in demand by 1987. Whether domestic suppliers can take advantage of this blessing of nature will depend on their ability to stem, if not reverse the import invasion which is now primarily product lead.

THE PRODUCT DEVELOPMENT TIMETABLE

STRUCTURE AND RESOURCES

The product development cycle is geared to meet the high fashion orientation of a market place which is seasonally dominated. There are four definable periods, two of which van be termed as leaders for any twelve month cycle, the others acting as transitional injections between the main seasons. They are in order of priority:

Autumn/Winter	- Main Range
Winter	- Seasonal
Spring/Summer	- Main Range
Summer	- Seasonal

A development timetable is established for each seasonal period, occupying a time slot of approximately six to nine months. Each programme is monitored by regular meetings, commencing with the Seasonal Brand and Range Marketing Strategy Review and culminating with a Sales Conference.

The six month monitoring meetings for any product development programme are designed to be sequential, each one focusing upon a particular aspect of the cycle. Table 3A outlines the title, purpose, staff and supportive documentation needed for each meeting.

CASE STUDY 'C' - TABLE 3A - PRODUCT DEVELOPMENT TIMETABLE

MEETING	TIME SLOT	PURPOSE	STAFF INVOLVED	DOCUMENTATION SUPPORT
1. Seasonal Brand + Range Marketing Strategy	Two Weeks	Marketing and Product Range Managers present a general strategic view for the season under discussion. Priorities determined in outline.	The Divisional Director. The Marketing Manager. The Product Range Managers - Three Groups. The Chief Designer. The National Sales Manager. The Production Manager.	Marketing issue: To Committee Members - Strategy document.
2. Major Product Development	Two Weeks	PRM's present initial proposals for each range, against agreed strategy and budget framework.	As Meeting 1.	PRM's issue: Design Briefs - To Chief Designer
3. Range Grid	Four Weeks	PRM's submit detailed proposals for each range with objective to achieving a release of a third of the new styles for factory development.	As Meeting 1.	PRM's issue: First Slot Summary - To Comm.Memb. Line Performance - To Comm.Memb. Line Release - To Comm.Memb. & Fact.Man. Range Grid Notes - To Comm.Memb. Design issue: First Materials Grid to Comm. Memb. and Fact.Man.
4. Range Progress	Five Weeks	As meeting three, but with all remaining designs agreed for release to factory.	As Meeting 1.	PRM's issue: Second Slot Summary - To Comm.Memb. Intermediate Bulk Release - To Comm. Memb. and Fact. Man. Design issue: Second Materials Grid to Comm. Memb. and Fact. Man.
5. Final Development	Three Weeks	PRM's present total range for review, including modifications agreed at previous sessions. Material specifications. Technical difficulties etc raised and discussed. Objective: Range agreement.	As Meeting 1.	PRM's issue: First Pairage + Material Forecast (P+M) - To Comm.Memb. & Fact.Man. Design issue: Final Materials Grid - To Comm. Memb. and Fact. Man.
6. Final Range Review	Four Weeks	PRM's submit final pre-Conference range, with samples and details covering sales forecast, forward stock, etc. Agreement sought so as to enable PRM to present commercial case to Conference.	As Meeting 1 plus Buying Manager	PRM's issue: Second P+M Forecast - To Comm.Memb. and Fact. Man.
				PRM's issue after Conference: Final P+M Forecast - To Comm.Memb. and Fact. Man.

Source: Marketing Manager - Procedure Notes

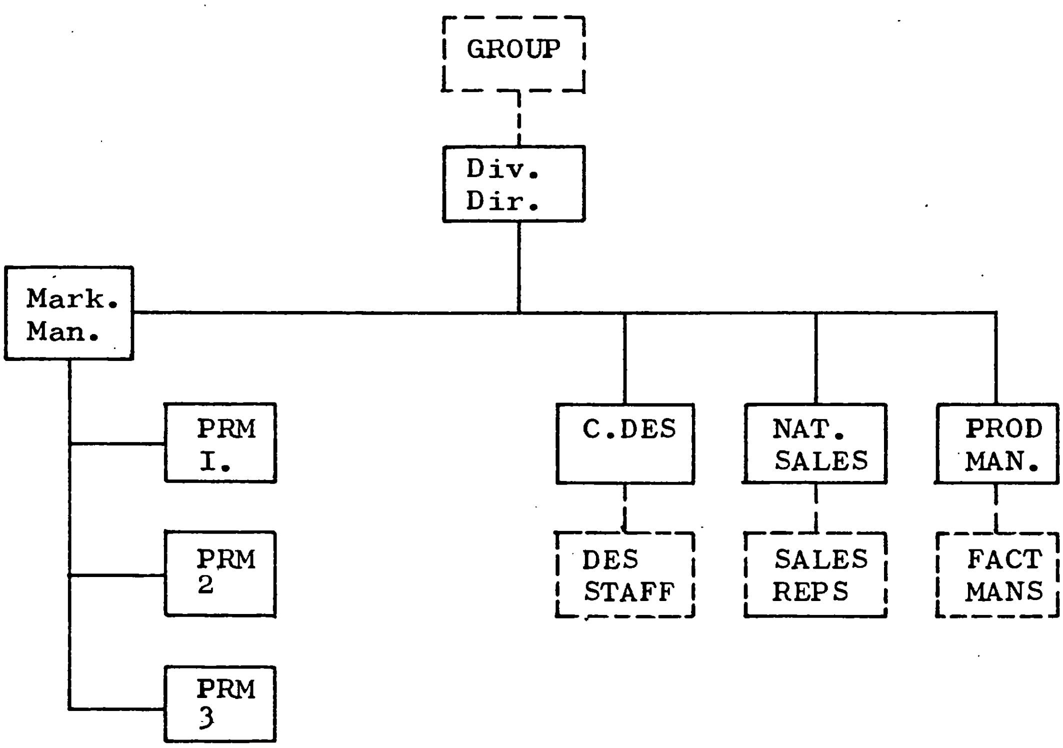
The Committee's membership, all located at the Group Headquarters was reduced at the end of 1982 to the current level. The areas now covered are:

Divisional Director & General Manager - Chairman.
Marketing Manager.
Product Range Manager - Group 1
Product Range Manager - Group 2
Product Range Manager - Group 3
National Sales Manager.
Chief Designer.
Production Manager.

Other specialisms are co-opted on to the Committee as and when required, e.g. Buying Manager for Meeting 6.

The Management Structure and reporting role of the Committee is illustrated under Figure 16.

FIGURE 16 Development Timetable Committee.



The Committee has a bias towards the marketing function with design, sales and production acting as balancing constraints. This is also reinforced indirectly by the Chairman's dual role of policy guide and arbiter. However, committee member responsibilities are radically different outside the meeting, the PRM having to adopt a negotiating stance with design, sales and production. The PRM's primary purpose as stated in the job description is:

"To research, recognize, rationalize and react to consumer demands in the market segment. Develop and market product ranges to satisfy those demands. Influence (Production) and optimize (Wholesaling) productivity and profitability through the range and thus ensure the continued growth - as market leader"

The job calls for wide experience. It encompasses such skills as an awareness of the delicate balance existing between commercial need and design flair, an understanding of the manufacturing dimension and knowledge of the retail scene as determined by the market place. The PRM is responsible for championing the product and uses his breadth of experience to persuade those involved to focus upon the product.

Therefore, although the Committee is marketing orientated and the PRM's natural authority is respected by its members, implementation must in the final analysis be on the basis of an acceptable solution to all parties.

The PRM has a key management function within the Development Timetable, the whole system relying upon the diplomatic effectiveness of those appointed.

Over the years a supportive documentation system has been evolved, designed to primarily assist in communicating product development intentions to various parts of the division - see Table 3A
The main documents are:

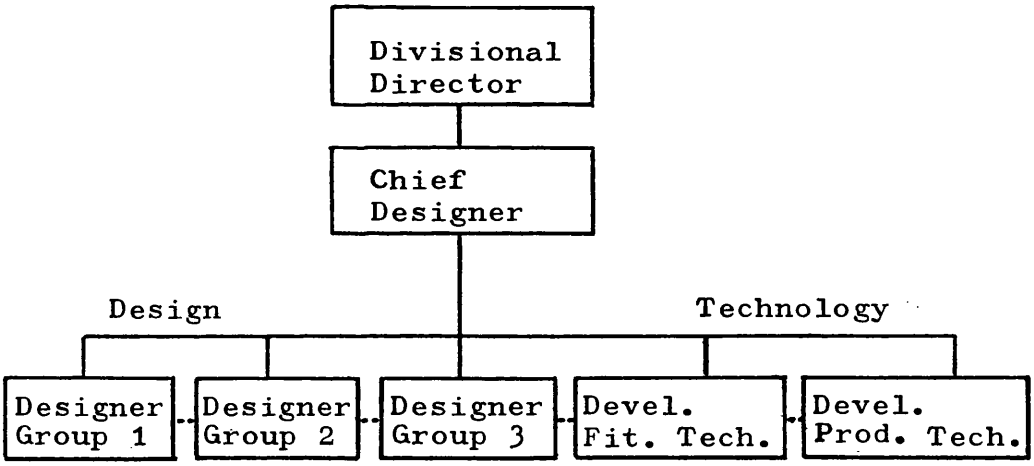
- Slot Summary - Details general intentions for the Seasonal Range.
- Line Release - Details released designs todate for manufacture of prototype/samples.
- Materials Grid - Details materials and colours.
- Intermediate Bulk Release - Advises anticipated production quantities.
- Pairage + Forecast Material - Details requirements for production.

The Design section also issue to the factories and independent of the Development Meeting a wax model schedule and later a specification grid which on occasions incorporates thumbnail sketches for easier identification.

It can be observed from the foregoing a PRM relies heavily upon the co-operation of the design and production areas to bring together a seasonal collection for a Sales Conference launch.

The Chief Designer has a team of five staff who split into two distinct activities, design and technology. The section operates as a team with individuals relating to each other laterally as indicated by Figure 17.

FIGURE 17 The Design Team.



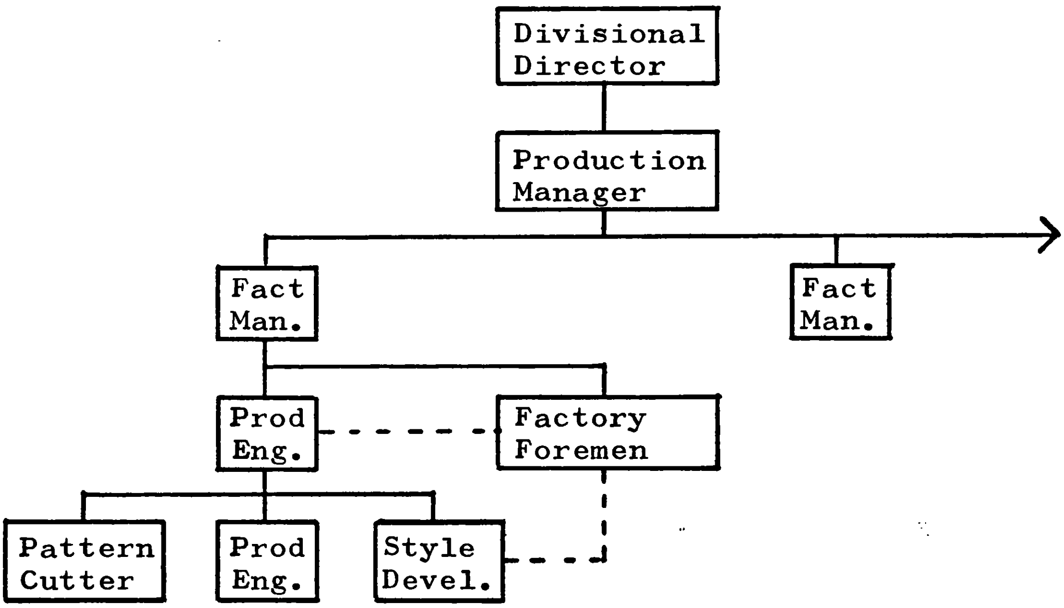
The two disciplines work in unison, the designers passing conceptual sketches to the technologists who interpret and supervise the building of visual samples. Designers are attached to specific projects and work for the PRM responsible.

The Chief Designer co-ordinates the section's activities, contributes to evolution of design policy through a formal and informal contact structure and undertakes as and when possible individual design projects.

The Production Manager's fundamental responsibility is the overall control of the Division's manufacturing resources located on six sites. Each main production centre is run by a Factory Manager who reports to him. In addition, pre-production development of new products is undertaken by the factories eventually responsible for bulk manufacture.

Each main factory unit has a pre-production team led by a Product Engineer reporting to the Manager in charge. The resource is a combination of specialist staff and foremen who represent the key production processes, as shown under Figure 18.

FIGURE 18 Pre-production Team.

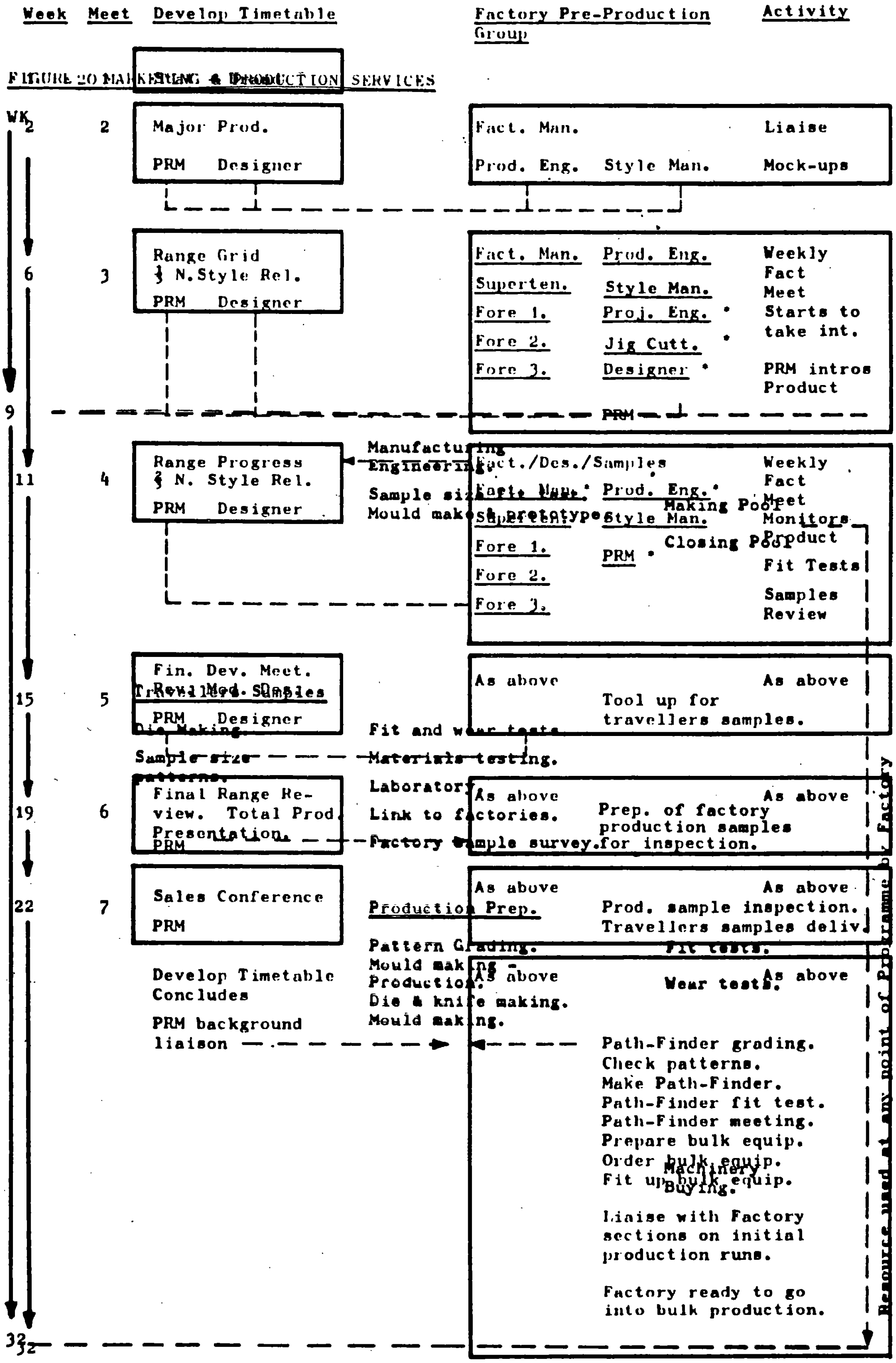


During the first six weeks, contact between the PRM/Designer and the factory is limited to the making of simple 3-dimensional mock-ups or if a totally new style, the development of wax models produced under the authority of the design section. During this initial period the Product Engineer/ Style Developer are involved in an advisory capacity, the true pre-production cycle not commencing until the design has been released. This usually occurs at the Range Grid Meeting, Table 3A, whereupon the PRM advises the factory and arranges for a formal introduction of the new product.

Attendance is drawn from the factory staff shown in Figure 18, the PRM and, on some occasions, the designer. The commencement of the factory input results in two separate, but interdependent product development channels. For some of the time they run in parallel and then upon the conclusion of the Sales Conference become primarily a factory based activity, the PRM providing monitoring support. Figure 19 outlines the vertical and lateral connections.

It can be seen the presence of the Divisional Production Manager on the development timetable is an essential factor if PRM proposals are to be assessed for practicality and cost effectiveness in terms of known manufacturing experience.

FIGURE 19 THE DEVELOPMENT TIMETABLE CASE STUDY 'C'



• = Sometimes

Source: Company Headquarters. Source: Company - Factories.

Source: Company Headquarters and Bath Factory.

FIGURE 19 **THE DEVELOPMENT TIMETABLE** **CASE STUDY 'C'**

Week	Meet	Develop Timetable	Factory Pre-Production Group	Activity
1	1	Stat + Brand		
2.	2	Major Prod. PRM Designer	Fact. Man. Prod. Eng. Style Man.	Liaise Mock-ups
6	3	Range Grid ⅔ N.Style Rel. PRM Designer	Fact. Man. Prod. Eng. Superten. Style Man. Fore 1. Proj. Eng. * Fore 2. Jig Cutt. * Fore 3. Designer * PRM	Weekly Fact Meet Starts to take int. PRM intros Product
11	4	Range Progress ⅔ N. Style Rel. PRM Designer	Fact./Des./Samples Fact. Man.* Prod. Eng.* Superten. Style Man. Fore 1. PRM * Fore 2. Fore 3.	Weekly Fact Meet Monitors Product Fit Tests Samples Review
15	5	Fin. Dev. Meet. Rev. Mod. Des. PRM Designer	As above	As above Tool up for travellers samples.
19	6	Final Range Review. Total Prod Presentation. PRM	As above	As above Prep. of factory production samples for inspection.
22	7	Sales Conference PRM	As above	As above Prod. sample inspection. Travellers samples deliv.
		Develop Timetable Concludes PRM background liaison	As above	As above Path-Finder grading. Check patterns. Make Path-Finder. Path-Finder fit test. Path-Finder meeting. Prepare bulk equip. Order bulk equip. Fit up bulk equip. Liaise with Factory sections on initial production runs. Factory ready to go into bulk production.
32				

* = Sometimes

Source: Company Headquarters. Source: Company - Factories.

However, the development timetable is also influenced by another agency originating from the Group's centrally placed Marketing and Production Services. The Manufacturing Engineering Sector supplies the majority of inputs, the most important of which are listed under Figure 20. Although the services offered are advisory in nature, they do have considerable impact upon any seasonal product programme, interacting primarily with the factories, the PRM and on occasions, the design section.

These three channels contribute to a typical development timetable and demonstrate an intense series of interactions over an average working period of 32 weeks. In an effort to clarify the priority rating, a simple two-part question, Appendix XX was put to a number of staff engaged upon the Summer Seasonal '84 programme. The results are summarized under Table 3B.

The two questions drew a wide range of answers from the 25 interviewees, suggesting individuals and sectors are generally unaware of each others contribution to the whole development activity. The lack of an overview can be more accurately discerned from the response pattern to the second question. Here the specialist functions of each sector are seen to prevail, matched only by an equally comparable vagueness of what occurs before or after.

TABLE 3B THE STAGES OF THE DEVELOPMENT CYCLE **CASE STUDY 'C'**

QUESTION		WHERE IS PRODUCT POLICY DETERMINED										
ANSWERS		Don't know.	Holdings Board.	Malcolm Cotton influence.	Divisional Director.	Marketing Department.	Assume Div/Hold Level.	Great unknown.	Divisional Managers.	Bottom/up. Top/down.		
STAFF	1	•										
DEV.TIME	2		•									
	3			•	•							
	4		•	•	•							
	5			•	•							
	6				•					•		
DESIGN	7	•										
	8					•						
	9	•					•					
	10					•	•					
FACTORY	11						•					
	12				•		•					
	13				•							
	14				•							
	15				•	•						
	16				•	•						
	17		•				•	•				
	18	•						•				
	19			•	•							
	20						•		•			
	21											
	22											
	23											
	24											
MANUFACTURE	25					•						
	26		•	•	•	•						

QUESTION		LIST IDENTIFIABLE STEPS FROM PRODUCT RELEASE TO FACTORY DISPATCH															
ANSWERS		Fit tests.	Approval of Last.	Moulding Tools & Order.	Pathfinder.	Bulk Production.	Materials Specification.	Final Costings.	Release to Factory PLM.	Design Spec rel to Fact.	PRM/Design monitor Fact. Quality to meet Spec.	Value Analysis/Eng.	Quality Control.	Back to Market approve.	Show to Retail/Consumer.	Sales Conference.	Sell to Retail/Consumer.
STAFF	1	•	•	•	•	•			•								
DEV.TIME	2	•	•												•	•	•
	3	•	•		•	•	•		•								
	4	•					•	•	•								
	5	•				•	•		•		•	•	•	•			
	6				•	•			•			•				•	
DESIGN	7			•	•	•		•	•								
	8	•					•		•								
	9	•				•	•		•								
	10	•				•			•	•	•					•	
FACTORY	11	•			•	•			•								
	12				•	•	•		•								
	13	•			•	•											
	14	•			•	•						•					
	15			•	•	•			•							•	
	16		•	•	•	•			•			•					
	17	•			•	•								•			
	18			•	•	•			•								
	19				•	•											
	20				•	•			•							•	
	21																
	22																
	23																
	24																
MANUFACTURE	25	•		•		•			•								•
	26	•			•								•			•	

QUESTION		LIST IDENTIFIABLE STEPS FROM PRODUCT RELEASE TO FACTORY DISPATCH (continued)																
ANSWERS		Wear Tests.	Specification issued.	Sample Factory run.	Catalogue.	Travellers Pairage.	Stock Control/Computer.	Order Components bulk.	Knives,Die,Jigs, order.	Identify faults,modify.	Another Pathfinder.	Pathfinder grade.	Check Patterns.	Computer Stitching.	Sample Inspection.	Store in Warehouse.	Develop Machinery	
STAFF	1	•	•	•	•	•	•								•			
DEV.TIME	2																	
	3																	
	4																	
	5									•								
	6			•		•												
DESIGN	7	•					•											
	8									•								
	9							•		•								
	10	•		•		•				•		•			•	•		
FACTORY	11			•		•		•				•	•					
	12						•	•								•		
	13			•		•											•	
	14		•	•					•							•		
	15			•					•	•	•					•	•	
	16	•		•		•										•		
	17			•		•												
	18		•	•					•			•		•			•	
	19			•		•												
	20			•					•							•		
	21															•		
	22																	
	23																	
	24																	
MANUFACTURE	25					•										•		
	26			•				•							•			

The absence of a common understanding by the sectors of what constitutes the key go/no go gates of a development cycle, reduces the opportunity for making those disciplined connections so essential for eventual success.

Examining the questions separately, it is interesting to note the wide divergence of opinion when it comes to deciding who is responsible for product policy formulation, particularly:

- The nearer the respondent to the Divisional Director the greater the perception of where Product Policy was determined.

- The more highly specialized the activity, i.e. Design and Manufacturing Services, the greater the level of uncertainty.

- Where there is geographical separation, the level of assumption or just plain ignorance increases.

- The surprisingly high number who equate marketing and product policy as one and the same thing.

In question two we can see a large measure of agreement between the sectors when it comes to handing the released design over to the factory, fit tests, the pathfinder and authorization for bulk production.

Other listed tasks tend to represent those perceived to be of importance to the sectors interests and assumed to form part of the cycle.

In addition, there is considerable confusion within various parts of the factory as to the sequence of events (other than the common denominators discussed earlier) for bringing a new product to the stage of authorization for bulk production.

It is estimated a minimum of twenty five people become involved in the birth of a new product, excluding manufacturing personnel other than foremen and those staff engaged upon stock control, marketing and retail selling. The quantitative split of the development team's inner core is shown under Table 3C.

Table 3C.

Development Committee	8
Design	3
Factory	7
Manufacturing	7

The technical/making resource equates to 56% of the total available labour and is over four times that supplied by the design sector, yet the visible lateral relationship of design and making is the weakest link within the whole Development Timetable.

The number of new or modified products initiated by the three genders commenced at 78, the former being in a ratio of just under 5:1. Those finally approved for marketing came to a total of 50 designs without colour or material options.

The feat of designing, developing and monitoring such a commitment through a 32 week period is no mean achievement. For a business engaged in a fast moving fashion industry, with a production infrastructure demanding high volume lines for good profitability, the question has to be asked whether such an input is necessary or even wise for each season.

Finally, the PRM's contribution is vital to the success or failure of any seasonal product programme. However, the product leadership role supported by the Development Committee's authority tends to be diluted when liaising particularly with the factories and manufacturing services. This does not mean there is no authority, but it may explain in part the observed lateral weaknesses within the current product development matrix.

To examine these and other factors further, the study will next explore the detailed progress of specific products selected in conjunction with the PRM's responsible from the Summer Seasonal '84 Collection.

THE PRODUCT CYCLE

In consultation with interested parties it was felt the investigation should centre upon products that had potential for encouraging design and production to respond innovatively to the issues raised, while at the same time focusing upon the connections taking place between them throughout the problem solving cycle.

Eventually two products were selected:

A. Group 1:
   Slot 14 Claudia
   Slot 15 Stella
   Slot 16 Elena
   Slot 16A Luisa

B. Group 3:
   Slot 3 Olympic
   Slot 4 Marathon

Both fell into an innovatory category in the sense they broadened the Company's penetration of market areas where they were either strongly represented or in the process of entering. Likewise, if design and production was to locate solutions that had sufficient market originality in what were recognised as highly competitive slots, a delicate balance would have to be struck between appearance, technical ingenuity and production skills.

Although the major objectives for each of the product slots had already been determined by the market plan and design briefs, both developments displayed a number of common characteristics:

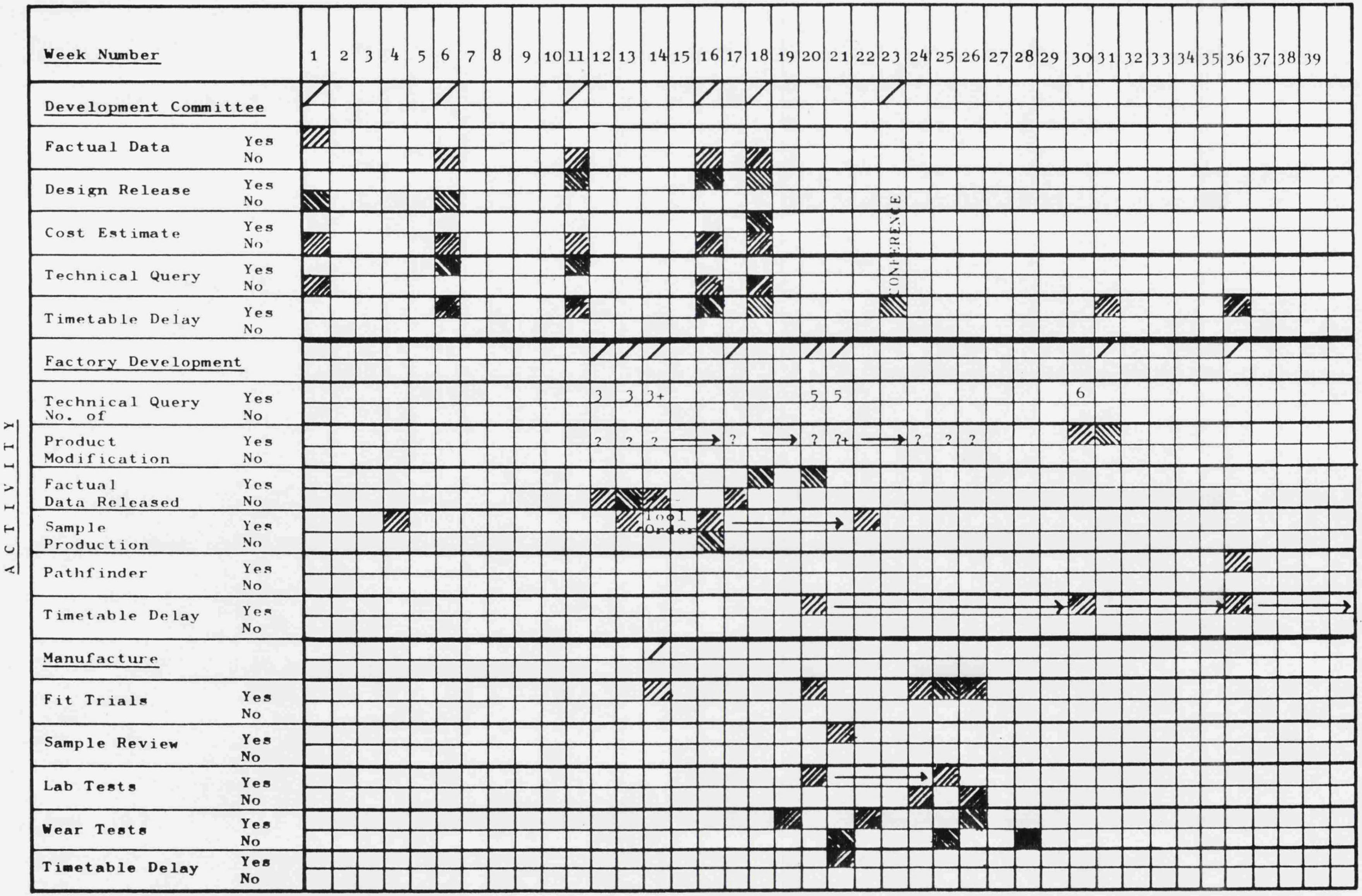
- New designs.
- A family collection of products for each slot.
- New tooling investment.
- Style options, but utilising common tooling.
- A market entry slot dominated by importers.
- Competitive market pricing, requiring close design/production liaison.

Figure 21 summarizes the development cycle experienced by one of the two selected products, which was either observed or monitored by discussion at the times shown. It divides into three activity zones. The Development Committee, Factory Pre-production and Manufacturing Services, which in turn are sub-divided into function categories.

It conveys in crude terms the time scale for each area contributing to the on-going product development matrix. The staggered profile underlines the progessive nature of the schedule and the lack of formal interconnections between the activity zones, heavy reliance being placed on the PRM's daily monitoring of the project or the informal communication network of the individuals concerned.

FIGURE 21 CASE STUDY 'C'

DEVELOPMENT TIMETABLE SUMMER SEASONAL 84. MONITORED CONTACT POINTS



Absence of lateral contacts on a structured basis is again reinforced by a series of events warranting special mention:

- Other than the first Market and Product Strategy meeting, no factual scenario data was put forward in support of the product concepts being advanced. In some cases competitor samples were produced to underline a point, but with little analysis of strengths and weaknesses.

- Each gender was presented separately, market overlaps or commitments in terms of capital and introductory production costs receiving only cursory attention.

- The divisional head office timetabled meeting cycle was virtually 50 percent completed before the factory became involved, other than the provision of samples for marketing evaluation.

- Prototype tooling was not authorised until early May (Week 16), six weeks prior to the Sales Conference. The late ordering prevented the conduct of viable wear tests until the middle of June (Week 20) which were followed by further trials in July. Results showed a need for design modifications, causing tool redundancy and inevitable bulk production delays.

- Within days of the PRM's factory release (Week 12), three areas of technical difficulty had been established, two of which were still awaiting a solution at the time of writing. By the time the Sales Conference was reached, the total had risen to five.

- A number of minor design queries were highlighted by fitting trials or factory based meetings. These were resolved as they arose, often in isolation and with minimum consultation.

The Timetable's Final Range Review did examine the total product range, pending agreement to show at the Sales Conference. However, because of the pro-market bias there was little opportunity for a critical appraisal of such factors as technical issues or production cost estimates.

At no point during the product's birth did all the associated parties meet to report upon and review the performance specification being achieved against the market targets determined at the outset of the Seasonal Programme.

It can be reasonably argued that the Committee's remit can and should not cover such depth of detail, but the question then has to be posed, where are such issues resolved? If a PRM responsibility, the authority to co-ordinate the skills involved and take appropriate decisions requires greater thought and emphasis.

From conversations held with members of staff engaged upon the development programme, it became clear the project timescale was a constant source of irritation, the factory stressing in particular the recurrance of missed deadlines by the Development Committee. The project studies proved to be of no exception. The complexity of the experienced problems gradually outstripped the time available, reaching a point where the samples for one of the designs arrived the night before their presentation at the Sales Conference. As one member of the factory team responible remarked ruefully, "Friday last we had nothing, today panic measures to meet bulk delivery schedules."

Empirical observation leads to the conclusion that either there is insufficient time or the Development Timetable's organizational structure is so fragmented as to mitigate against any chance of achieving effective completion for anything other than seasonal modifications of existing products.

The act of taking a product from inception to market launch is complex and it maybe appropriate to recall examples of published material that have theoretically explored and delineated in considerable detail the key phases of the problem solving process as it applies to Product Design.

The past fifteen years has witnessed considerable research and Table 3D lists the sequence of events as perceived by two independent sources. What is quite remarkable is their similarity despite the divergent backgrounds of the authors. The only area of real disagreement is the positioning of the prototype phase within the development cycle, Corfield (13) preferring a detailed assessment before committing funds, possibly reflecting his engineering background. Whatever the approach, the design of any system for monitoring the progression of a product programme must incorporate applicable decision check points before moving on to the next phase.

Although such a system can aid those engaged in product development to become more effective, unless it is tailored to accommodate the business's idiosyncrasies including the prevailing commercial environment, it can become more of a liability than an asset.

As discussed earlier, the Company is a large manufacturer of a wide variety of fashion orientated artefacts, selling in a market sector that is becoming more volatile by the month and pressurized by import penetration.

TABLE 3D.

THE PRODUCT DEVELOPMENT CYCLE

Stage	Route One	Route Two
1	Establish Strategic Objectives.	Identify need or want.
2	Preliminary Research.	Specification.
3	Feasibility.	Relevance of product. (Effect on existing sales, available technology and production capability).
4	Design Development.	Conceptual Design.
5	Prototype Development.	Preliminary Cost Estimate.
6	Reappraisal.	Evaluation.
7	Production Development.	Detail Design.
8	Production Planning.	Prototype.
9	Manufacture.	Manufacture.
10	Production + Sale. (Includes evaluation for second generation).	Product Launch.
11	-	Product Review.

Source: Professor L. Bruce Archer. Royal College of Art.	Source: Sir Kenneth Corfield. NEDO.
Design Awareness.	Product Design.

Such a profile demands the continuous introduction of competitive designs, but the division's production resources are conceived to perform at maximum efficiency for single style products with potential for high volume sales.

Consequently, the Development Timetable needs not only to react flexibly and quickly to changing circumstances,but also to encourage the emergence of designs that offer style options without causing production facilities to move into a lose situation.

A Design Council report (39) cites examples of where competitors are able to design a new product range within two to three weeks and have it ready for bulk delivery by the end of three months. A similar capability characterizes the Italian industry who are now responsible for the majority of quality imports into the United Kingdom.

A large number of competitors, including those from overseas are medium to small scale enterprises, and it is suspected do not suffer from unnecessary organizational complexities when undertaking the design and development of new lines. On the other hand, they often lack access to technical and scientific resources taken for granted by the larger business. The most acute disadvantage encountered by the majority of bigger groupings centre around effective communications, whether between specialisms, skilled operatives or departments whose members, though possessing similar qualifications, practice them at varying levels of competence. It was once said by an executive of a leading European company:

"The problem with trying to turn an idea for a new product into an economic, reliable and marketable reality is that transferring knowledge through an organization is like carrying water in a sieve".

In this case, we have a priority for a communication system which will recognise and harmonise the disparate skills of a development team drawn from a number of primary activity zones.

When this requirement is also examined against a perceived lateral weakness in the structure of the development timetable; the question of how the group views the product and the level of agreement reached becomes important. Exploration of these issues with those responsible for the two analysed products was guided by five questions:

- The origin of the product brief.
- The critical design factors.
- The three key functions within the total cycle.
- The methods adopted for communication
- The product's major external competitors.

The responce patterns are summarised under tables 3E and 3F respectively.

What emerges is a surprising degree of unanimity, hinting at alevel of product awareness and commitment not normally associated with the large enterprise Further reinforcement is provided by the depth of market and import knowledge displayed by a majority of those questioned and reference to commonly used buzz words i.e. elegant, crisp, colour, care and concern to describe attributes believed to improve the product's potential in the market place. The need for

CASE STUDY 'C'

TABLE 3E PRODUCT VIEWS

QUESTION	ANSWERS	1 DEV.TIME	2	3	4	5	6	7 DESIGN	8	9	10	11 FACTORY	12	13	14	15	16	17	18	19	20	21	22	23	24	25 MANUFACT.	26
HOW DID THE PRODUCT COME ABOUT	COMPETITION FROM OTHER SOURCES		•	•	•	•	•			•				•	•					•	•						•
	OBSERVATION OF TRENDS	•	•			•	•		•		•			•	•	•	•			•	•					•	•
	TALKING TO RETAILERS	•																									
	INNOVATION+TECHNOLOGY NEED		•																•								
	ADULT FASHION INFLUENCE		•	•																							
	NEED FOR A FAMILY OF PRODUCTS				•			•													•						
	LOGISTIC DEVELOPMENT OF EXISTING PRODUCTS						•				•	•	•			•	•	•	•								
	NEVER SEEN PRODUCT BRIEF	•				•			•	•		•	•	•	•	•	•	•	•	•	•					•	•
WHAT ARE THE KEY CHARACTERISTICS WHICH NEED TO BE ACHIEVED	ELEGANT/CLASS/STYLE/CRISP	•	•	•	•	•	•	•	•		•	•	•			•		•		•	•						
	DRESSY/FINE/LINE/FEMININE			•				•						•													
	REFLECTIVE/QUILTING/LACING									•	•							•									
	STRENGTH/LIGHTNESS										•									•	•						
	GOOD DETAILING/STITCHING			•		•		•				•				•		•									
	WELL MADE/QUALITY/SECURE				•	•						•		•	•		•										
	MODERN COLOURS & MATCH			•		•	•		•		•			•			•			•							
	CARE AND CONCERN		•				•				•				•					•							•
	BRANDING									•	•																
	SHOP WINDOW/EYE APPEAL												•														•
	CHILD/PARENT APPEAL		•	•			•			•											•						•
	COMPETITIVE PRICE		•		•		•													•							•
	DON'T KNOW																		•							•	
WHO ARE THE THREE KEY PEOPLE IN THE PROD. DEVEL. CYCLE	PRODUCT RANGE MANAGER	•		•	•	•		•	•	•	•	•	•	•	•	•		•	•		•						•
	CHIEF DESIGNER/MARKETING				•		•	•																			
	DESIGNER		•		•				•	•	•	•	•		•												
	FACTORY MANAGER/PROD.MAN.	•				•	•																				
	PROD.ENG/STYLE DEVELOPER	•	•	•		•		•	•	•	•	•	•	•	•	•	•	•	•		•					•	•
	FACTORY - SUPERINTENDENT			•												•		•			•					•	
	FACTORY - MAKING FOREMAN													•			•										
	FACTORY - CLOSING FOREMAN																•										
	QUALITY/PRODUCT ASSURANCE																										•
	SALES MANAGER																		•								
	TEAM EFFORT																			•							
	MANAGER - FITTING		•																							•	
OTHER THAN THE DEVELOPMENT TIME TABLE HOW DO YOU COMMUNICATE DURING CYCLE	MEET CUSTOMERS/RETAILERS	•			•		•																				
	MEET FIELD SALES	•																									
	WEEKLY/DESIGNER/PRM MEET		•	•			•	•			•																
	DISCUSS PROJECT WITH DESIGNER			•		•		•	•																		
	SHORT NOTICE MEETINGS				•		•						•														
	LOCAL SCHOOLS/CONSUMER TEST						•																				
	WEEKLY FACTORY MEETING		•									•		•	•	•	•	•	•		•						
	PATHFINDER MEETING											•				•					•						
	FACTORY PRM BRIEFING AND LIAISON		•			•	•		•		•	•			•	•	•	•	•								•
	LAID DOWN FACTORY DEVELOPMENT MEETING DEADLINE												•							•							
	FITTING TRIALS		•	•				•	•						•											•	•
	SAMPLE REVIEW															•											•
	UP TO INDIVIDUAL/HAVE GET TOGETHER																	•			•						
	INFORMAL CONTACT/TELEPHONE	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•					•	•
WHO ARE THE MAJOR COMPETITORS	ADIDAS, NIKI, LEVI						•			•	•							•	•								
	BSC. BHS. LITTLEWOODS M&S	•	•		•	•	•				•	•				•	•	•	•	•						•	•
	BALLY/RAVEL/BIRTHDAY/START-RITE			•	•			•				•			•	•	•										
	DOMENEY/MARIA PIA	•	•		•																						
	WHOLESALE AGENCIES					•																					
	IMPORTS	•	•	•	•	•	•	•			•	•	•		•	•	•	•	•	•						•	
	ITALY/BRAZIL	•	•			•																					
	LOW PRICES		•		•																						
	UNBRANDED																										•
	SPECIALIST SHOPS																	•		•							
	CHILD SELECTION							•																			
	DON'T KNOW - REALLY								•			•		•			•				•						

the division to enter the fashion league by taking note of customer preferences is also keenly appreciated.

When it comes to assessing the knowledge centres (limited to three) who make the most viable contribution to the development cycle, the Product Range Manager and the Product Engineer/Style Manager axis virtually share the honours. Designers trail a respectful third, losing support from the factories despite the qualified recognition accorded by the pre-production staff. The PRM is seen by all parties as the central figure, success or failure depending upon the ability to negotiate a way through the maze of conflicting interests.

Table 3E/4 clearly illustrates the already noted structural fragmentation, PRM's endeavouring to achieve a substance of lateral communication with design and pre-production, though on a strictly ad hoc basis. The most systemized profile emerges from the factories. All respondents emphasize the informality of contact, but the dot pattern still underlines the internal strength of each zone's communications, blame tending to be apportioned to those outside the magic circle when delays or difficulties occur.

But it is in the answers given to the methods of communication used by the four activity zones, the committee, design, the factories and the manufacturing services that highlights the great Headquarters/ Factories divide. The amount of face to face problem solving contact is minimal, each side tending to speak with their own kind. The position can be no more aptly illustrated than by the transcript of a sales/design and production exchange of views at one of the range review progress meetings:

Sales/Design	Production
	Has the proposal been checked out with the factory?
Yes!	I don't believe it!
	Why do we have to go for holes?
No need if too difficult for the factory!	The design is too heavy!
We need a high standard of design, not 'bull-shit'!	

Finally, it is interesting to note in Table 3F, under Manufacturing Resource how differently the development committee and the production units assess technical problems associated with released products; again suggesting the latter's representation at the Development Timetable level may be unsatisfactory.

Nevertheless, the overall findings give grounds to believe the foundation for a more participative product development format already exists and if such a change was implemented, a considerable wealth of commitment, knowledge and expertise would be released to the long term advantage of the division.

CASE STUDY 'C'

TABLE 3F

QUESTION		ANSWERS	1 DEV.TIME	2	3	4	5	6	7 DESIGN	8	9	10	11 FACTORY	12	13	14	15	16	17	18	19	20	21	22	23	24	25 MANUFACT.	26
HOW DOES THE PRODUCT REFLECT THE COMPANY'S	PUBLIC IMAGE	CHANGING FROM TRADITIONAL			•						•		•							•		•	•					
		FASHIONABLE + FIT			•	•	•	•		•																	•	•
		HEALTH + FIT	•	•					•					•	•	•	•			•	•							
		HARD WEARING - QUALITY		•										•		•	•											
		BRANDED						•																				
		U.K. MADE	•																									
		DON'T KNOW										•							•									
	MARKET POTENTIAL	AS PUBLIC IMAGE. DONT KNOW				•				•	•	•		•		•						•					•	
		MARKET LEADER						•																				
		FIGHT FOR MARKET SHARE											•															
		BECOMING A LEADER AGAIN	•	•			•		•											•			•					
		MOVING INTO FASHION			•		•								•				•		•		•					•
		TEND TO FOLLOW																				•						
		MOTHER/CHILD APPEAL			•																							
		GOOD QUALITY RIGHT PRICE															•											
	INNOVATIVE CAPACILITY	CONSOLIDATION OF EXPERTISE	•					•		•				•	•					•		•					•	
		EXCITING LOOK WITHIN TECHNOLOGY			•	•	•			•																		
		SHOULD BE CAPABLE ANYWAY																										•
		EQUAL TO ITALY				•																						
		NEW TO FACTORIES										•																
		NEW CONSTRUCTION, LAMINATED		•					•				•				•		•		•		•					
		DIRECT MOULDING	•											•		•												
		COMPONENTS, BUT TRAD. MAKING																										
		IMAGE		•																								
		NEW TECHNOLOGIES	•				•			•	•					•							•					
	MANUFACTURING RESOURCE	HEADACHES TEETHING PROB.										•	•						•	•			•					
		WITH CREDIT - SATISFACTORY		•	•		•		•	•											•						•	•
		ADJUSTMENT DIFFICULTIES				•		•			•				•		•		•			•						
		BUILD UPON CURRENT KNOWLEDGE	•	•									•	•														
		HIGH VOLUME TECHNOLOGY.																										
		OLDER PEOPLE WILL HAVE DIFFICULTIES														•												
		COULD UPSET NORMAL PRACTICES															•		•	•			•					
		LESS WORK CONTENT																		•		•						
		TRAINING REQUIRED															•											
		CHANGE NEEDED																	•	•		•						
	LONG TERM CORPORATE VIEW	DON'T KNOW							•			•								•			•					
		KEEP PACE WITH CUSTOMER		•	•								•				•		•		•	•					•	
		MOVE INTO FASHION	•	•		•	•	•		•	•			•	•	•	•		•		•	•					•	
		KID APPEAL-YOUNGER LOOK	•				•			•																		
		LACK EXPERIENCE ATTITUDE CHANGE													•													
		BECOMING INNOVATIVE											•															
		BUILD ON EXISTING STRENGTH																										•
		BRANDING + HEALTH	•			•				•																		
		NEED TO GET ON WITH IT														•												

A publication to commemorate the group's 150th Anniversary states:

"There is always a temptation to tailor an operation to what the public wants, rather than create products that the public cannot resist. But in the past it was done, and it can still be done. This emphasis on quality, - - - - - allows the worker engaged in making to take a pride in what he makes. Without the worker, the whole is nothing".

Summary of Case Studies

Study 'A'

The chairman has a powerful influence on product creation, referred to by one of his colleagues as 'a gleam in his eye'. His capability and natural leadership is respected and recognized at all levels within the company.

The product development cycle covers a minimum period of two years. It has five major phases:

- Product concept.
- Concept evaluation.
- Concept Board approval.
- Product detail and development.
- Market introduction.

The longest and most complex section is the product detail and development period, which involves a variety of inputs drawn primarily from design engineering and production. Communications are extended and involve internal and external resources including the use of sub-contractors.

There are two crucial creative stages, the chairman's view and design engineering's detailed thinking.

Despite the relaxed style of internal communications, design engineering and production harbour differing perceptions of each other's role.

The lack of lateral contact between design engineering and production is again reinforced by the answers given to questions relating to product success or failure. However, when these are examined collectively they expound a cohesive view. What then prevents effective communication?

Study 'B'

The Managing Director has a strong personal interest in design and technology, recognized by R & D staff.

The majority of new products emerge as a result of customer enquiry.

The New Business Enquiries Committee evaluates all proposals on a yes/no three criteria weighting:

- Does it fall into existing product experience?
- How complex?
- Will it be profitable?

The product cycle has been known to extend into a decade, but the average time scale hovers around 2 - 3 years. Three sectors are primarily involved:

- The Commercial Department.
- The Engineering Sector.
- The Manufacturing Division.

Once a project has been approved, the cycle has four phases:

- Preparation and submission of a design/technical prospectus for customer acceptance.
- Engineering development.
- Pre-Production detailing and planning.
- Manufacture and delivery.

The longest and most complex is the third phase.

There is a lack of contact between the Commercial/ Engineering axis and Manufacturing. This is accepted as normal practice by all parties, not least Manufacturing, who stated on one occasion 'Design tell us what is required and we just implement it'.

There is an absence of lateral relationships, none of the parties finding very much common ground.

Finally, the Control Systems Manual details the implementation procedures to be followed by each sector but failed to provide an overview of the product cycle.

<u>Study 'C'</u>

The Divisional Director took a strong personal interest in new product development.

The Development Timetable Committee is responsible for product development, membership drawn from marketing, sales, design and production.

A Product Range Manager champions nominated projects and works with three key areas:

- Design.
- Factories of the division.
- Group manufacturing services.

The product development cycle covers an average period of 12 to 15 months. It has seven major phases:

- Market strategy and briefing meeting.
- Design and prototype development.
- Concept approval.
- Factory development.
- Product testing.
- Factory pathfinder trials
- Manufacture and delivery.

Approximately 25 individuals become involved at some stage with the product development cycle. The longest and most complex phases are centred on the last three.

Two products were selected to observe and evaluate the methods used to control the product cycle. The key points to emerge were:

- A lack of PRM co-ordinative authority.
- Absence of effective lateral communications between the various sectors.
- The late identification of technical/production problems, and over 50 percent of the cycle being completed before the factories became involved.
- Staff frustration at the lack of clear information.

The results of an internal survey suggest a higher than normally expected product awareness already exists between members of staff engaged on the product cycle. However, there was a discernable communications gap which gave rise to serious product development problems.

The findings have a number of common threads which, it is submitted, can be viably condensed into three distinct, but interrelated parts. Firstly, the absence of defined product strategies, second, a serious design to production communications gap and thirdly, a narrow and uninformed conception of the design process. Some authorities have attributed a lack of making the right cross references or as it is sometimes described, 'convergence' of significant functions at the most senior operational levels, as one of the main causes for the problems outlined. This viewpoint is given some support by Twiss, (48) who looked at, with the aid of 200 directors and senior research managers, the problem of making effective contact with the market place. He identified two major hurdles:

- ' Communication difficulties between technologists and marketing managers '.

- ' Company organizations which hinder than assist effective communications between them '.

In the next chapter, 'Connections' it is intended to explore in general terms ideas that may have some bearing and application to the issues raised by the case study research.

Chapter III

Connections

Connections

The task of bringing marketable ideas, which are to be manufactured to a stage of economic realization is recognized by general consent to be a difficult, if not hazardous enterprise; the latter sentiment often being quoted at an unguarded moment in the confines of the local, as the primary cause for getting out of manufacturing and moving into importing for an easier and less exhausting living. It is not our brief to muse on the social and historical factors that may have contributed to a national disinclination to become involved in the making of things; Weiner (50) and Dahendorf (16) being two more recent voices to a debate that has been going on for 130 years, when Dr. Lyon Playfair (42) in response to Lord Granville's request said of the 1867 Paris Exhibition " I am sorry to say that with few exceptions, a singular accordance of opinion prevailed that our country had shown little inventiveness and made little progress in the peaceful arts of industry since 1862".

However, whatever the causes for this lack of enthusiasm for the manufacturing dimension, the brief encounter with some of the Case Study skills engaged in the provision of solutions for the production of marketable ideas has exposed the sheer complexity and level of co-operation needed to realise a satisfactory result. For as has been indicated circumstantially by the analysis, product creation is not solely the prerogative of the marketing department, the designer, the technologist, the crafts-person or sales, but a pooling of talent on a basis of mutual respect, which gains its recognition and reward through the art of manufacture. Successful products carry a natural authority, Burberry, Sony, Smarties, Olivetti, Rosenthal, Workmate to name but a few, and though often started by singular inspiration become quickly absorbed by the implementing enterprise, the business being the product and the product being the sum total of the skills and experience available to the business. In other words, the product is the central issue or as the late Akio Monita, co-founder of Sony once said "we are selling diamonds".

But such commitment is not founded upon sentiment or a romantic stance, but on a basis of respect for the product that is hard nosed, demanding and confident. This sense of achievement by the artifact is movingly portrayed by a 1795 account of the first iron bridge at Coalbrookdale (47) "the noble arch.......exulting as it were in the strength of its connected massy ribs, reared its lofty head triumphantly above the mighty torrent and would have given an undaunted and generous reception to double the quantity; neither huge logs or timber, nor parts of houses which come with such mighty force made any impression on it - it firmly stood and doubtless braved the storm" and again in 1801 (47) when the latest developments of Coalport were being described, "In the vicinity.......in a large warehouse erected over the Canal, the end of which is washed by the River Severn over which stands a wooden bridge, supported by 3 setts of cast iron ribs. The whole of this lively and beautiful place with its erections belongs to William Reynolds. Ironmaster.......a liberal promoter of the different Arts and Sciences, ...and to whom the nation stands greatly indebted".

Here, we can just about glimpse some of the thrill felt by what was seen in the Dale, spoken in the same sense of awe that is today reserved by journalists for some Japanese act of industrial prowess. The history of 1795 leaves the impression that despite the hazards of the industrial environment as created by the Reynolds and Darbys of the time and the social deprivation, the results achieved came about because the projects, though not managed in the modern sense of the word were led, and the people concerned, including the men who made the moulds and cast the prefabricated elements, participated in determining the final outcome. There are interesting footnotes to some of the documents held by the Iron Bridge Museum, that record unexplained items of expenditure, "nine guineas on ale on the 23rd October", in 1779, probably to celebrate completion of the main structure, or a comment from one of Darby's cousins "I suppose it will all be cast in the Dale for Cousin Abram will have the whole direction", which virtually confirms the personal commitment. Of course, it was much easier then, no large corporations, multi-nationals or professional specialisms to fog the issues, or dampen enthusiasm, instead the scale was small enough to permit those concerned to learn on the job and communicate ideas for potential solutions on a pretty well instantaneous basis. The objective was the building of the bridge, the manufacture of the segments to allow for its fabrication coupled to an extension of known technology, being the principle means for its realisation.

It was, it is suspected, an unstructured matrix of inputs, similar to those found in the Case Studies that played a major part in the manufacture of Iron Bridge and now, according to Freeman (21) so seemingly well emulated by the Japanese when he says they "have been more successful than any other industrial nation in a systems approach to design, which recognizes the integrative, coupling role of innovative management, relating product design and process design to world technology and world-wide markets". We shall return later to this particular aspect, but suffice to say contemporary records of Britain in 1800 portray an atmosphere where manufacturing was able to gain a creative dimension; a concept which finds an echo in the Finniston Report's phrase (20) "the engineering dimension", which envisages an organisational system that allows engineering and non-engineering factors to interact and where the unity of the manufacturing process is recognized and not just aspects of it. Finniston was, of course, proposing such a widening of the horizon from the engineers point of view, the premise being that whichever branch, mechanical, electrical, civil, etc., to name but three of the 80 odd separate specialisms, they are involved in each stage of the manufacturing process, from technical appraisal to design, sale, delivery and service. Certainly, the need in educational terms to enhance the engineer's and equally, the industrial designer's perception of the roles played by design and technology inconjunction with other functions, does require radical attention, but they are still aspects, critical maybe, but aspects of the whole manufacturing environment. The report does accept that efforts made to raise the performance of British manufacturing have lacked a unity of purpose, comparable to the best practices adopted by other advanced industrial societies, but not surprisingly, the primary recommendations to emerge are people centred, instead of product centred.

Crowe (15) makes the same error, when he argues that providing aspects of the designer's life-style, appearance, time keeping, attitudes to authority and method of working are not pushed to the point of confrontation, they will not be deterred from working in an industrial climate. The Design Council has also tended to promote a similar line of argument, accusing industry of not using and employing enough designers; whereas it may be more fruitful to place the whole debate on to its head and ask, why is it that British engineers and designers do not use industry, for surely they have a shared commitment to and interest in the product?

The Manufacturing Dimension

Commentators, when discussing Britain's poor trade performance with regard to the design and making of products, often treat the words 'manufacturing' and 'production' with a degree of laxity that can lend support to Ruskin's 1869 contention that, 'while manufacturing is the work of hands only, art is the work of the whole spirit' or give the impression the two words are one and the same thing; for instance '.......Those on the manufacturing side do not want the additional problems that are imposed on them by design'. (23). The term 'manufacturing' is derived from the latin word 'manūfactus', of which 'Manūs' by the hand and 'Factūra', the making or fashion of a thing, based on the word 'Factum' to make, are the constituent parts. Manūfactus as translated by the Oxford Dictionary (41) implies 'the hand as the instrument of human work'. Chambers (12) confirms the origins, but acknowledges that it is now usually applied to all forms of making activity, whether hand or machine orientated. However, Webster and Random

House(49,43)propose a wider scope to meet contemporary conditions, describing it as 'the act or process of working, inventing, devising, fashioning' or to 'compose by combining things, parts or elements'. This concept is in part given further credence by the Cabinet Office paper 'Industrial Innovation' where manufacturing is recognized to have related sciences, with particular emphasis placed upon the links between production processes and the design, quality and reliability of products.

Production in this context is seen to form a part of manufacturing, an assumption supported by a variety of definitions, 'the action of producing, bringing forth, making or causing' (38) or 'then he goes into the production shop where he gains experience of the many aspects of aircraft construction'(40). Here it is clearly shown to be related to doing something on the premise that it is unable to stand alone, for without the product, the play or the document, whatever the context, it cannot function effectively. Alternatively, the word can be used to encompass a collection of related sub functions directed at a predetermined objective or as a 1966 New Statesman advertisement, sampled by Oxford English (40) proposes, 'a production controller to supervise the production section from manuscript to bound copy'. In other words, upon receipt of the text and graphical design of the book, co-ordinate all those tasks that will enable it to be printed, collated and bound into a finished article ready for distribution to the market. The same source also indicates the word can be used to mean, 'the planning and control of the manufacturing processes, plant and equipment in the production of any manufactured product'; stress being laid here upon a manufactured product, manūs by the hand, factūra, the making of a product.

It could, therefore, be reasonably argued that the term manufacturing can be applied to activities, whether they be hand, machine or computer led, that are concerned with the making of things and destined for use by human society, the thing having its own integrity, irrespective of the level of technical or craft capability available to the enterprise responsible for its creation. Manufacturing as thus defined, can be likened to the canvas of an artist, where the forms, colours and spaces in between are governed by the composition of the whole or as Lorenz (30) terms it "the status of manufacturing". Further, the product and skills brought together to bear upon its realisation, learnt, handed down and developed by each generation in a spirit of care and concern, has on many occasions been perceived to create an environment in which the whole man becomes manifest, possibly not in the sense of Botticelli, but likewise not the work of hands alone. Mant (33) illustrates this dimension beautifully with a 1950's story of Mercedes Benz, who despite the lack of public interest in matters of safety, continued to crash cars because 'at the heart of the enterprise was a devotion to the product itself which represented the glue that held the enterprise together spiritually as well as technically'; an attitude similarly found to be lurking in the majority of respondents from the Case Study analysis of the last chapter.

Hence, it may now be possible to catch a glimpse of a structure with some substance and application to the argument advanced so far and at the same time anticipate a foundation for meeting the primary frustrations elicited by the field research.

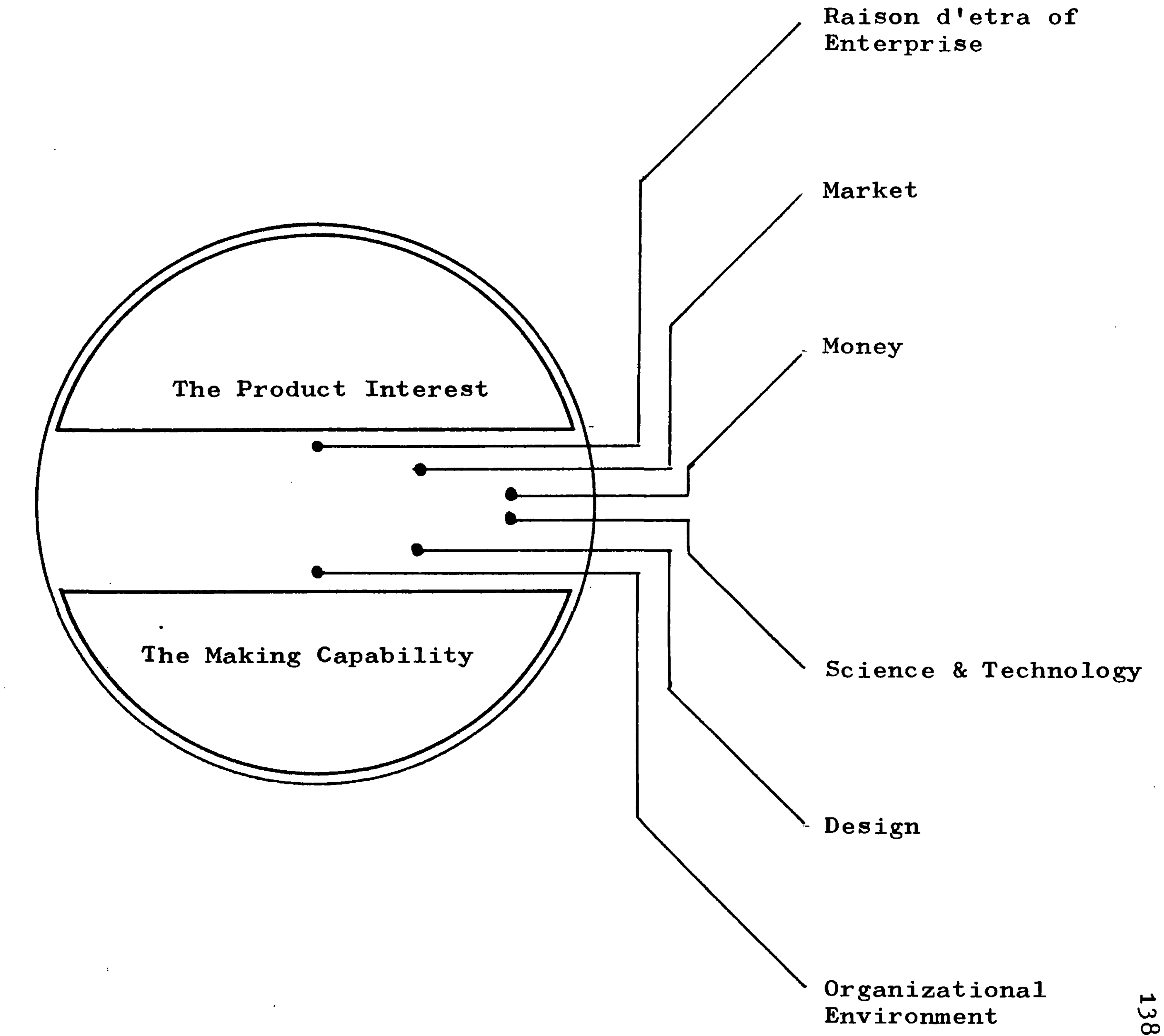
Figure 22 portrays a conceptual view of a manufacturing dimension which is driven by a two pronged core, made up of the product interest and the making capability, which though physically separated from each other, in the sense, the product eventually leaves the manufacturing environment, are nevertheless interdependent for determining the success or otherwise of the enterprise. The quality of the results achieved will, however, also be subject to the influence exerted by a third and equally vital component of support services, that fills the gap separating the two core elements. Consequently, it is believed there are three essential contributors:

- The area of product interest.
- The making capability.
- The quality of the space left between.

This last component designated 'a strengthening membrane', encompasses a collection of internal and external influences that facilitate the on-going maturity of the enterprise, while generating a unity of purpose for serving the needs of the product. Naturally, the composition of the mix must adjust to prevailing circumstances, but six support functions are felt to be particularly pertinent to the discussion in hand, namely:

- Raison d'etre of the enterprise.
- Market.
- Design.
- Science and Technology.
- Money.
- Organizational environment.

FIGURE 22



Manufacturing Dimension

The structure as so far outlined is minimal and is intended to be, for the purpose is to clarify those principles which could have an impact on the development of a manufacturing dimension. There appear to be four:

Balance

In the first instance, the structure of the design needs to maintain a delicate balance in the relationships that will exist between the two cores, product and making (on the basis the former is only as good as the sum total of the latter), the support services located in the space between them, and the quality of the points of contact within the space, such as the design and production interface; with the intention of creating a climate where those taking part recognize that their authority comes from the primacy of the product.

Communication

Following balance, but no less vital, is the conviction in what Mant [34] describes as the Swedish assumption, that irrespective of the hierarchical position of the individual, the manufacturing task serves as the basis of role relationships, with any adjustments coming about as a natural consequence of events and future developments. In other words, participation on a basis of mutual respect.

Money

Thirdly, sufficient case law has now been assembled to show that the generation of financial stability within a manufacturing environment comes through giving priority to supplying the right product, for the market, at the right time, and not as Mant (33) so succinctly puts it by, 'laundering money'. Therefore within this scenario, money is seen as a commodity to maximise the potential of the product.

Innovation

Finally, the point of gravity occupied by the design and development sectors requires re-location nearer to the centre of the enterprise's core to take on Hudson's (25) contention 'that innovation is easiest perceived by people who are in some way or other marginal'.

The identification of an approach to be adopted towards the ingredients of balance, communication, money and innovation, as part of a wider organizational structure for the supply of manufactured goods, does not mean the enterprise cannot acquire a clear personality or bias, i.e. market, technology or finance led. To the contrary, but it is being proposed that if the core attributes, the product, the skill resource and the end user are not seen collectively as the primary objective, under constant vigilance by the whole community of the business, then the chance for the enterprise to sustain any measure of continuing success is slim. Expertise to oil the wheels is one thing, but without the product's status they are nothing. It is more than probable the sensitive alienment of such principles gave the Darby Iron Bridge the success it deserved. Conversely, Raleigh's (10) insensitive decision to market in the U.S.A. bicycles manufactured in Taiwan, cost them credibility and loss of market share. It is a classic story of where the business forgets its roots and in so doing, offends both the product and the user.

In the last chapter, discussion with respondents drawn from the commercial, design and production functions clarified to a reasonable degree of convergence, five areas of perceived concern:

- Demand of a wide skill base to implement new designs for production.
- Individuals concerned with product development experiencing difficulty in visualising the scope of the cycle and their place within it.
- Poor internal communications at inter-sectional level.
- A concern for and interest in the product.
- Recognition that there was no Product Strategy.

With such a strong interest shown by the majority in the Company's product, who it must be remembered were drawn from areas as far apart as the shop floor to the boardroom, suggests there may be one myth of British society which could benefit from some structured research.

The received wisdom since World War II as annunciated by the Design Council, designers and fellow travellers, is that the great British public, with some exceptions, are unconcerned about design. This sentiment is often expressed in the same breadth as the phrase, 'visually illiterate', the two terms tending to become merged and seen to be complimentary. However, as previously noted, many of the individuals engaged in some part of the design process as practised in the case study companies, identified a whole range of attributes which they felt constituted good design. The problem was not that they were disinterested in design, but were frustrated from making a contribution, because of the systems adopted by their companies for implementation. This observation of an actual situation, leads to a natural querying of an official assumption, that the British consumer is design illiterate, more so when it is realised the U.K. has the highest percentage of imported consumer goods of any country within the EEC, plus one of the most developed retailing and distribution systems. Taking the latter, Doblin (17) in 1980, while conducting a preliminary investigation of the U.K. volume retailing industry, put forward the hypothesis that 'as times get tougher.......consumers become more interested in what they're buying'. But the paper's most pertinent comment is reserved for the tendency of shoppers to place product features into priority cluster groups. Consumers apparently during the process of sorting out priorities, are able to quickly determine those that are unimportant, while merging the remainder into a ranked specification of attributes for the intended purchase. In spite of the many recognized imponderables such as TV promotion, life style, and a lack of objective data on how consumers perceive quality, Doblin confirms experience has taught that reliability, efficient performance and appearance head the list for most products. Ignoring the last, where one man's meat can become another's poison, it is interesting to note how the other two priorities make a natural connection to the many headings identified by case study respondents. These very earthy considerations again feature in an interview between the Designer magazine and John Wakeham MP (35) when in response to the question, 'Is design important to you personally' he said:

'Yes, it is. I don't know that I am terribly well tutored in design, but for instance it irritates me beyond measure when you find a car door that doesn't shut properly, because that is bad design in my book'.

It is a great tragedy the design world has managed to get itself into a position where industrialists and the public alike, sees the role as primarily to do with the way things look and not as a method for solving a problem to meet a need. Even Corfield (13) falls into this schizophrenic trap by the remark, 'Product design is defined to include both engineering design and industrial (aesthetic) design'.

The sketched linkages are admittedly tenuous and do warrant as intimated by Doblin further study, in an effort to distinguish more precisely those criteria which do or do not meet the shopper's perception of quality. But the brutal truth is that the absence of such knowledge has not prevented the two most successful manufacturing nations, Germany and Japan, from penetrating our markets to a point where it is not credible to believe the British are not aware of design. It really depends on what is meant by design.

Here we enter a minefield and it is not part of this study's remit to engage in debate, but it is recognized an outline view is necessary for underpinning a concept of the manufacturing dimension. Designing has been described as a 'process of seeking a match between a set of requirements and a way of meeting them or finding an acceptable compromise'. (32) In a lecture given on the examination of design in industry, Lorenz (30) indicated that it went well beyond the external shape or colour of a product, contradicting a popular view held by many an industrialist. Instead 'good design' is linked by Lorenz to the ease of producing the product, the phrase holding maintenance, in use performance, cost effectiveness as well as marketability in equal regard, with the latter making a significant contribution to the appearance of the end result. He also aptly notes that the major reason why top managers have so much difficulty in perceiving the role of design in manufacturing industry, is simply the combined failure of designers and engineers to agree amongst themselves on what constitutes design. Freeman (21) suggests the continuing attempts to define 'design' as not only a rather unrewarding occupation, because of the absence of any recognized international understanding for statistical purposes, but also suspect, citing Christopher Jones's explanation 'to initiate changes in man-made things' as being so broad as to be virtually meaningless. Freeman prefers to concentrate attention on to the functions of design in manufacturing, recommending the process breaks down into four discreet, though related activity zones, some of which will be needing to overlap in organizational terms for a satisfactory economic result. They are listed as:

- 'Experimental' covering the initiation of ideas and prototyping.
- 'Routine' associated with tasks to prepare the design for production.
- 'Fashion' where aesthetics becomes the dominant factor.
- 'Management of Innovation', which synthesises the above three plus others for the launch of a new product.

Gorb (22) lends additional weight by coolly referring to design as '......a planning process....can, but need not necessarily be, concerned with the aesthetics....'.

Freeman and Gorb reflect quite remarkably the sequence of events and conditions witnessed in all the case studies, and especially with the functions who had a responsibility for translating the prototyped idea into the eventually marketed product. However, the opinions expressed have, it is believed, another layer of particular significance. They rightly acknowledge aesthetics as a major component of design and very much so when the product is destined for the high street. But this aspect is seen as a part of a total design presence, where, inconjunction with the previously referred to sub-parts, plus the service inputs such as marketing and others, a total contribution towards the primacy of the product field served by the enterprise takes place. This approach implies infiltrating the product with the folk lore, experiences and skills available from within the originating firm, and matching them to the external trading environment with not only conviction, but also affection. Support for this method comes from Lawrence (27) through an American case study in which a recently appointed designer, worried about the company's commitment to design was advised, 'Don't be concerned about the president, work with the operating divisions; go where the money is'. Since receiving that tip, so the story goes, the design department has gone from strength to strength with the number of staff rising from 2 to 44 in six years. Germany and Japan appear to have learnt the organizational trick for integrating design into the business. The question then is, what are the operational principles and how could they assist to overcome some of the problems found by the field research at the production and design interface?

Evaluation of the information gathered in Chapter II led to the conclusion that a primary cause for the implementation difficulties encounted during the product cycle, rested on the way sectors and individuals alike saw their roles, how they should be played and the parameters of the tasks thrown up. Much of the heartache and frustration experienced in the case studies can be laid at the doors of the systems used for driving the product cycle; where to a greater or lesser degree there was a failure to promote the art of participation from which, if it is practised correctly, a respect for capability and attention to detail emerge as tools for getting the product right first time. Participation is the umbrella for the other two, all of which are practised, some would say obsessively by Japanese and German manufacturing industry; though the historical roots and the forms taken are quite different. There are, however, a number of common characteristics which are felt to be relevant to this study and can be summarized as:

- A wish to encourage initiative.
- A tapping of bottom-up experience.
- A respect for training and skills.
- A concern for quality.
- A desire for two-way consultation.

As a group they represent a formidable creative resource for utilization by the enterprise and when deployed at the implementation stages of the product design cycle can, it is suspected, make all the difference between success and failure. All of them are captured in a single unique institution for each country, the Meister (Foreman) in Germany and the Japanese tradition for consensus.

The Meister

The role of the Meister in German manufacturing industry cannot really be assessed without a brief glance at the cultural tradition embodied by the term 'Tecknik'. The word as translated by Lawrence (28) portrays a manufacturing dimension which encompasses 'the knowledge and skill relevant to making things and making them work'. No such equivalent term exists in the English language, the nearest parallel being the phrase 'Applied Science, which though relevant to the use of knowledge for the resolution of an engineering problem, does not cover the actual application of physical skills. 'Tecknik' does in Lawrence's opinion in which he finds support from Archer (4) who describes it as 'the knowledge of the world of action'. Finniston (20) adopts a rather more pedantic interpretation in relating it to 'the synthesis of knowledge frommany disciplines to devise technical and economic solutions to practical problems', which possibly concurs in a roundabout fashion the linkage of knowledge to making. It is certainly not a purely technical term, quite to the contrary, as it is often used in an organizational sense, where everybody from the shop floor operative to the Managing Director are participants in 'Tecknik'. It is within this framework the job of 'Meister' needs to be viewed.

The position is equivalent to the role of the Foreman over here. But that is as far as the comparison can go, for unlike the British Foreman, the status of the Meister is acquired by undergoing a period of training in addition to the original apprenticeship, which culminates in the taking of an examination and if successful, the award of a state recognized Meister-brief (Foreman's letter). The significance of such an achievement is not only the right and readiness to practice as a foreman when invited, but also confers from society a mark of respect.

At every level of training in the federal republic, from the commencement of an apprenticeship to becoming a Meister, the individual, as well as learning to cope with the elected craft skills, is exposed to all the various aspects of the business including costs, design, and the planning and administration of production. The final Meister examination also covers subjects as far apart as mathematics, materials science, process technologies to estimating and industrial law. No wonder as the excellent NEDO report (24) on the German machine tool industry intimates, 'This leads to a very particular relationship between the shop floor and management, with the Meister playing a key link role and achieving very real recognition for his role'. The Meisters and their key staff are expected to make a contribution to the on-going development of the enterprise and, therefore, to the product cycle through participating in the detailing of new products as part of the design team, where their practical knowledge and skill is respected. 'Tecknik', when coupled to the role of the Meister forms part of a cultural heritage, which in the words of Lawrence 'transcends hierachy and becomes a force for integration'.

Japanese Consensus

The tradition to consult, listen and reach a decision that is a distillation of the views expressed goes back beyond the 19th Century when Japan commenced her programme of industrialization and modernization. The system known as 'Ringi' has feudal origins, when it was accepted practice for middle ranking officials in the political structure to evolve policy options for implementation by the top echelons, on the principle that if it encountered resistance or proved to be ineffective, the authorities would emerge unscathed. With the advent of the Meiji era, the system readily adapted to the demands of the new bureaucracy and today still is the foundation of the consultative process used in the majority of Japanese business concerns. The word ''Ringi' as conveyed by Sasaki (44) means 'obtaining approval on a proposed matter through the vertical and sometimes horizontal circulation of documents to the concerned members in the organization'.

The system is normally initiated at middle management level, with no top down involvement and is subject to clearly defined principles and procedures for completion. It is time consuming and calls for dedication from the author of the idea, who is usually a member of a department, but rarely its head. During the exploratory phase, in which the head's approval has already been sought, the concept is presented to and discussed with departmental colleagues. With agreement reached on a proposal that has more than likely been modified, it is then offered to sectors and other interested parties outside the department for evaluation.

However, in this second and what appears a crucial stage, it is still up to the originator and staff of the department under the leadersip of the head to arrange meetings, conduct the informal and formal sounding-out sessions, prepare and circulate the papers and do all the running about to win acceptance. The commitment of the section must be seen to be total. The final period leads to the emergence of an informal agreement with all of those consulted and is only brought to conclusion once the author perceives that consensus has been reached. At this point and only here, is a formal proposal document put together and circulated to the 'Ringi' group for signature and, if a traditional format is adopted, the appendage of a seal which is unique to each signatory. The idea is now ready for dispatch to the Board for consideration and approval.

From such a system, which is apparently even today used by a minority of Japanese Institutions, have sprung a myriad of adaptations to cope with changing conditions at the workplace, plus other innovative developments in which the natural right to be consulted and take part in the decision making process is retained. The most internationally renowned is the 'Quality Circle', pioneered in the late 50's to meet initially a requirement for involving the shopfloor in making recommendations that would raise productivity, without a loss of quality. Significantly, the process now permeates every level of activity in quite a number of Japanese concerns, from the President to the factory floor; whereas the European and American variants tend to be considered for use in the latter area, with no application elswhere. However, of interest are the distinct parallels to the Meister system, particularly the role of the foreman who acts as the linchpin between the quality circle team of approximately 10 people and other functions within the organization; a development which it should be remembered has taken place in spite of the very disparate cultural traditions of both countries. The Japanese, like the Germans, see participation as a key tool for the generation of 'bottom up' influences to cause design and technical change and in so doing, ensure the total resources of the enterprise are directed upon the product. Hitachi in one year received 2.3 million suggestions, Toyota have been known to achieve an average of 15 proposals per head, of which 83 percent were acted upon.

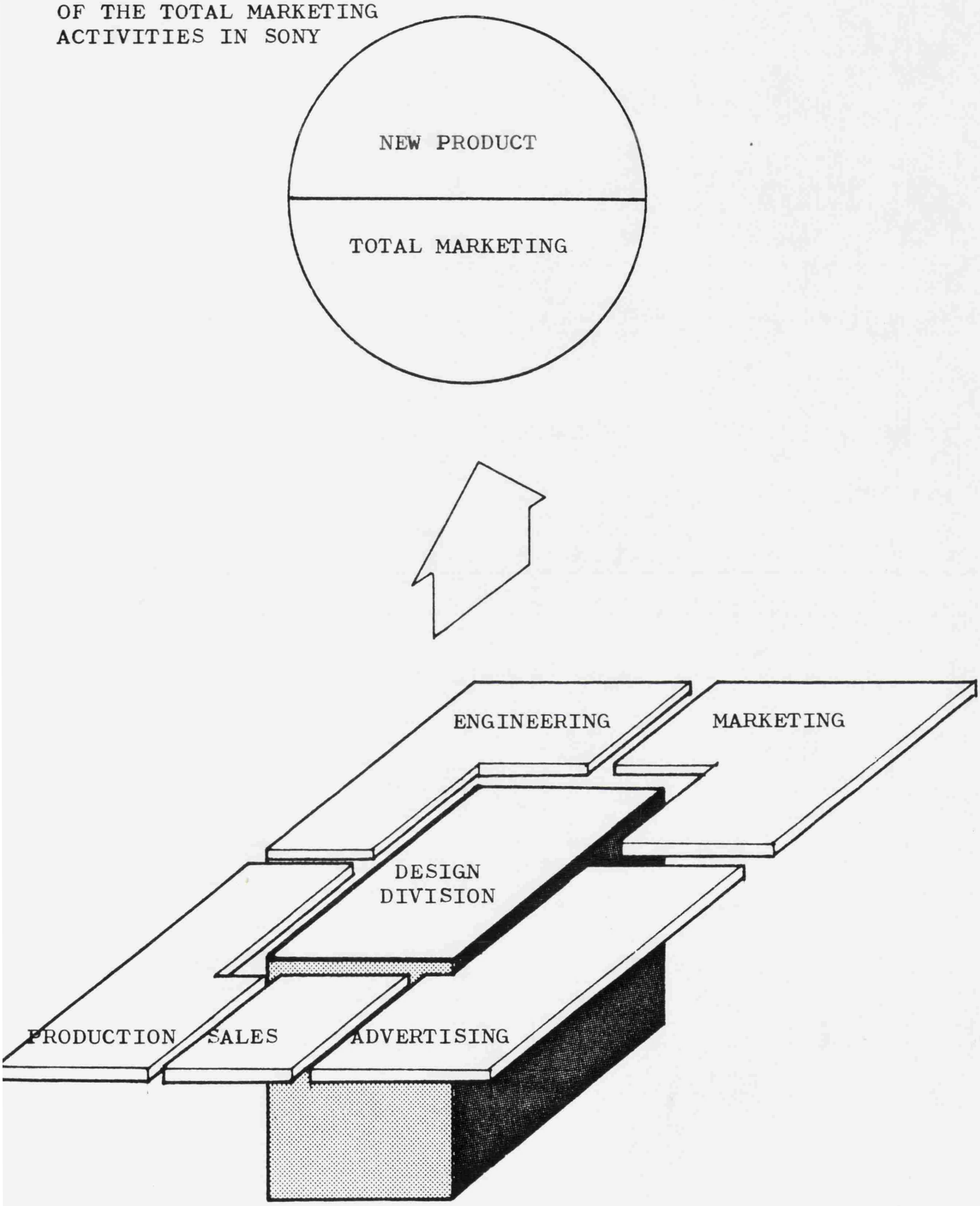
Wolfgang Schmittel (9) a Sony admirer once listed eight characteristics believed to have led to the inexorable progress of the Company:

- Contribution to the fullness and joy of life.
- Above all, design must be beautiful.
- Originality based on the newest technology.
- Functionalism.
- High quality.
- Rationally designed products for mass production.
- Relativity and conformity to the system.
- Consistent design, continuous enhancement of Sony identity.

Whether his subjective assessment truly reflects Sony's attitude to the product is not known, but their organizational structure shown under figure 23 confirms how design occupies the heart of the Company's thinking. It does, however, lean upon and interact with the making experience, the technology and the other support functions that are servicing the

DESIGN DIVISION
AS THE CENTRE CORE
OF THE TOTAL MARKETING
ACTIVITIES IN SONY

FIGURE 23.



Source: The Sony Exhibition, Boiler House, London. 1982 product areas in which Sony has decided to have an interest. Such integration was singularly absent from the design and production interface of all of the case studies, as was also the organizational matrix; two fundamental principles that have possibly done more to give the Germans and Japanese such an effective manufacturing dimension, where design becomes the product's life force and innovation occurs as a natural consequence.

Innovation in the above context goes far beyond the normally accepted definition of being the commercialization of technological change. As the Japanese never fail to continually remind us, it has to actually synthesize a chain of activities. These can start with fundamental and applied research leading through to marketing, production and the diffussion of processes, skills and other resources. Like any chain, it is only as strong as the links between and breakage, due to a lack of attention to detail or the mismatching of people, will render the whole process impotent. The Cabinet Office (6) does partially attest to this view by saying it '......means considerably more than just invention. That is just the beginning of the innovative chain'. But the paper goes on to give a slightly wooden rendering of the process, relating it to the translation of ideas into manufactured, working and marketable products, or ingremental modifications of existing designs, machines or materials. Unfortunately little mention is made of how innovation grows from systems designed to engender a certain level of creative tension, as the Sony model or as is so often the case, just casually in response to circumstances. It also fails to bring out the potential for excitement, so brilliantly conveyed by Lorenzoni's (31) fascinating Prato study.

Prato, near Florence in Italy, is one of the country's major centres for the textile industry. Since the 1950's the infrastructure of the region has undergone radical change, caused initially by economic decline and then with regeneration. The result has been the creation of over 13,000 business units, most of which are engaged in some aspect of textile manufacture. The majority are medium to small family businesses who tend to specialize in particular cloths, manufacturing processes or machinery supply. The whole region can be likened to a vast textile enterprise, with many of the constituent parts interlinking and when necessary, combining to meet specific market circumstances.

Despite working under intense competition from the Far East and other parts of the world, Prato is one of the few profitable textile centres remaining in Europe. Lorenzoni's studies propound a variety of reasons for this phenomena, some of which are of particular significance:

- Quicksilver response to new market demands.
- Creative and adaptive designs, underpinned by a capacity to confer status through innovatory methods or processes.
- Leader led, drawing upon pooled experience and external knowledge.
- Acceptance of the stresses and risks of change.
- Outward looking, backed by finely tuned international awareness.
- Recognition of native skills and strengths and a capability to consolidate them.

Considerable emphasis is laid upon the innovatory process, described as intense, continuous, fast, requiring qualities of tenacity and determination with maximum utilization of expertise and skills readily at hand. As he remarks "What makes a Prato product competitive today is not so much its price, as its characteristics". In a climate of this intensity the product can easily move into the realm of a love object, sustained by personal commitment of such quality, that innovation becomes more a way of life, rather than an event. When this occurs, it can be argued innovation takes on a highly creative role by causing the organization to integrate, as well as to accept change. It validates the performance of those engaged at all stages of the product cycle without fear or favour, and encourages the dismantling of artificial barriers, including the ones that separate design from production. The product and the external operating environment are two constantly moving targets and it is the quality of the match of ideas to native experience that is the essence of successful manufacturing. For such a goal to be realized, the design function needs to start from the point where production begins and not be external to manufacturing's core, which is the product.

A Product Cycle Model for Case Study 'C'.

If manufacturing is about the business of making things, than the dimension is an enabling mechanism for the principal partners, makers, the product and buyers. Although these three represent the core, they are unable to stand alone and to function effectively require an injection of a servicing catalyst, permitting the product to be created, produced and bought. For the core and the services to gell, an innovatory loop of knowledge and experience is required to generate a participative climate that is fun and encourages the enterprise to realise its potential.

When the manufacturing dimension, as in Case Study 'C' is dominated by a low technology environment, similar possibly to Prato, the maxim 'the Company's basic strength is and will always be its product' becomes an essential prerequisite for continued survival. In this situation, innovation assumes a role that transcends all departments and functions within the business and deletes the artificial division between innovation and design, the former on occasion qualifying as the higher priority.

In these circumstances, the design of the operative framework requires careful attention; balancing the need for creative contact between the various inputs, whether top down or bottom up, with the taking of decisions that are meaningful to the business's short and long term interests. In addition, despite each system having its own characteristics to meet local idiosyncrasies, it will more than probably wish to take into account the following factors:

- History and traditions of the enterprise.
- Evaluation of the product and associated skills or knowledge learnt to date.
- Level of commitment to the product.
- The structure of the market and points of access.
- Average product life cycle.

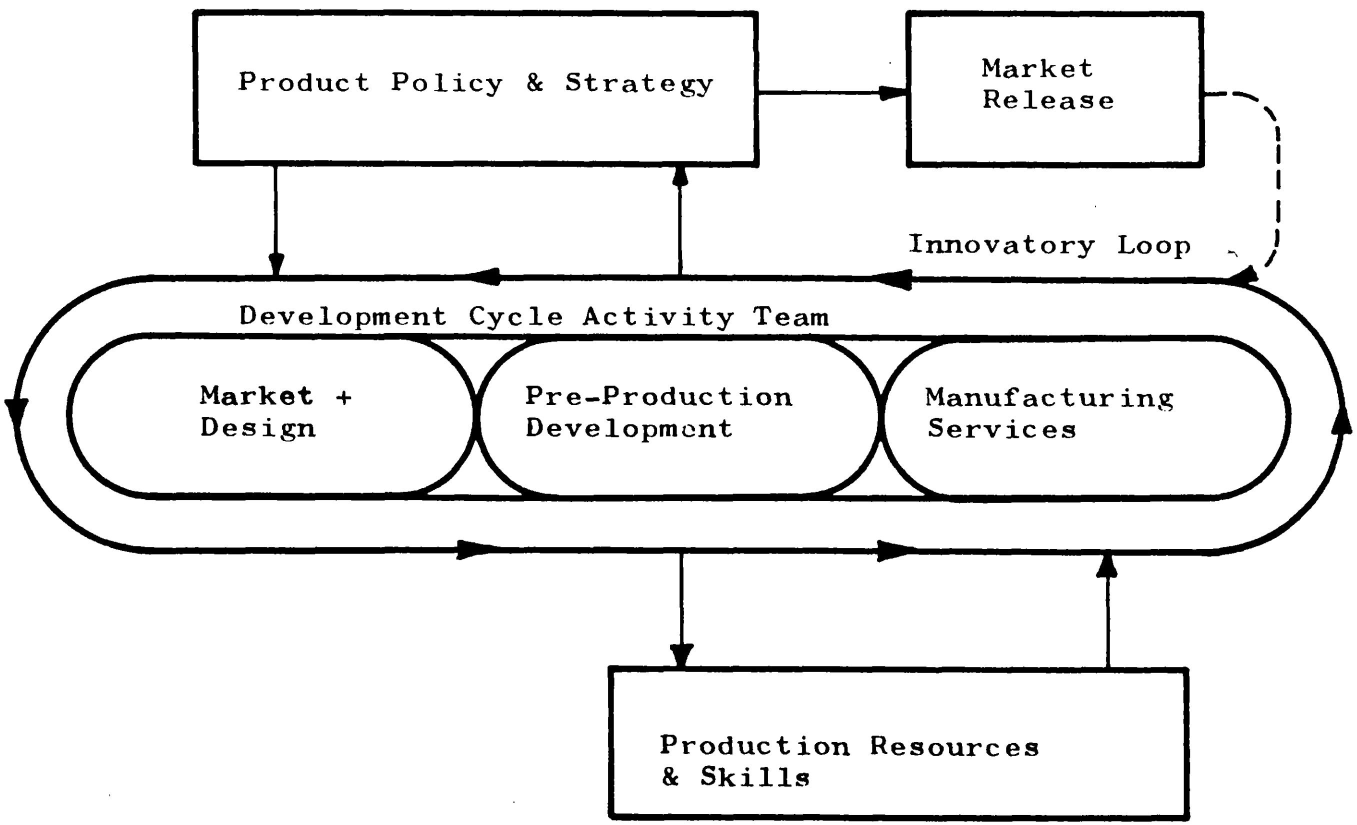
- Range of skills required for the creation, development, production and purchase of the product.
- The desirable levels of invention, design and innovation to sustain a forward, but competitive position.

Bearing in mind the criteria outlined, a possible model for raising the level of product performance in study 'C' is featured under figures 24 & 25. The first part of the model, figure , suggests a three-part, closely knit and interdependent structure, incorporating:

- A central innovatory team who embody the core knowledge areas for implementing the Development Progamme's product briefs, accepting responsibility from inception to authorization for bulk production and market delivery.
- A top down product stategy and performance monitoring body, supporting or otherwise the recommendations of the innovatory team and providing the enabling resources for the programme's completion.
- A bottom up technical, craft and gut feel experience group, drawing upon actual making expertise and intuitive perceptions for influencing the innovatory loop.

The lateral shape equals the open ended but controlled interactivity of the core team. The ongoing rotation characteristic offers reciprocal contact points for the bottom up and top down contributors as and where necessary, the whole designed to respond and focus upon the central issue, the product.

FIGURE 24



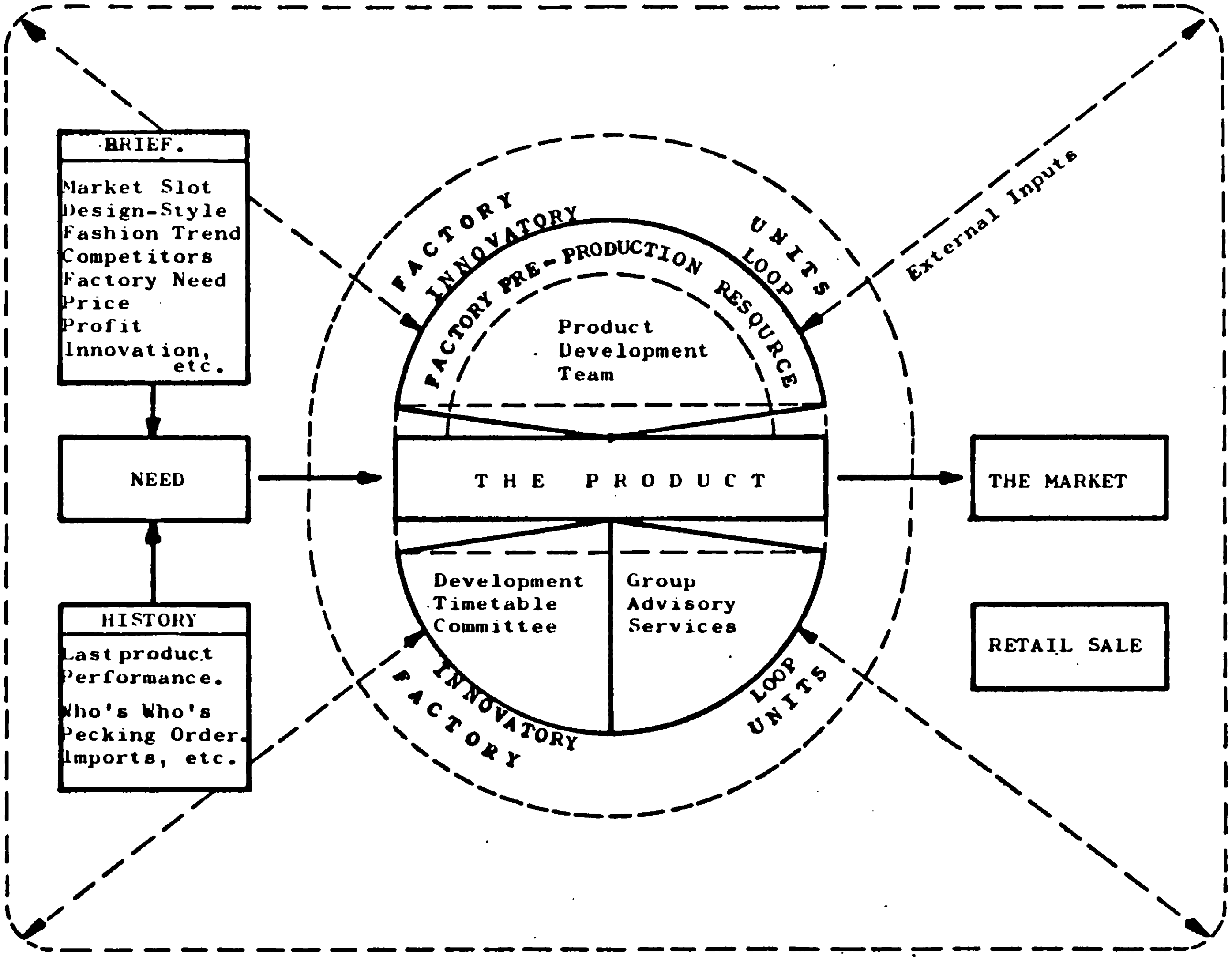
THE INNOVATORY PRODUCT DEVELOPMENT CYCLE LOOP

However, as already noted in the field study analysis, the division works in a market that is subject to unusually wide parameters, encapsulating the child where the parent still has a guidance role, though in decline, to the young adult who relies on peer group approval and the fashion media to close the high street sale. The scenario is further complicated by the servicing of both genders and the concentration of retail buying power, the latter being accustomed to having what they want, from where and when, loyaties counting for little.

The second part of the model, figure 25 , gives recognition to these variances, including the division's geographical location vis-a-vis the production units and the centrally placed advisory services of the group. The product occupies the centre of the tripartite structure, the sectors undertaking specific functions either independently or in concert, depending upon the stage of the development cycle. These relationships are also reinforced by an organizational weighting consisting of:

- A newly constituted product development team, led by the Product Range Manager and responsible for implementing the designated main or seasonal product development programme from conceptual sketches to authorization for bulk production.
- A Development Timetable committee endowed with a client status and matching credentials to approve, modify or reject PDT submissions.

FIGURE 25



THE PRODUCT DEVELOPMENT TEAM

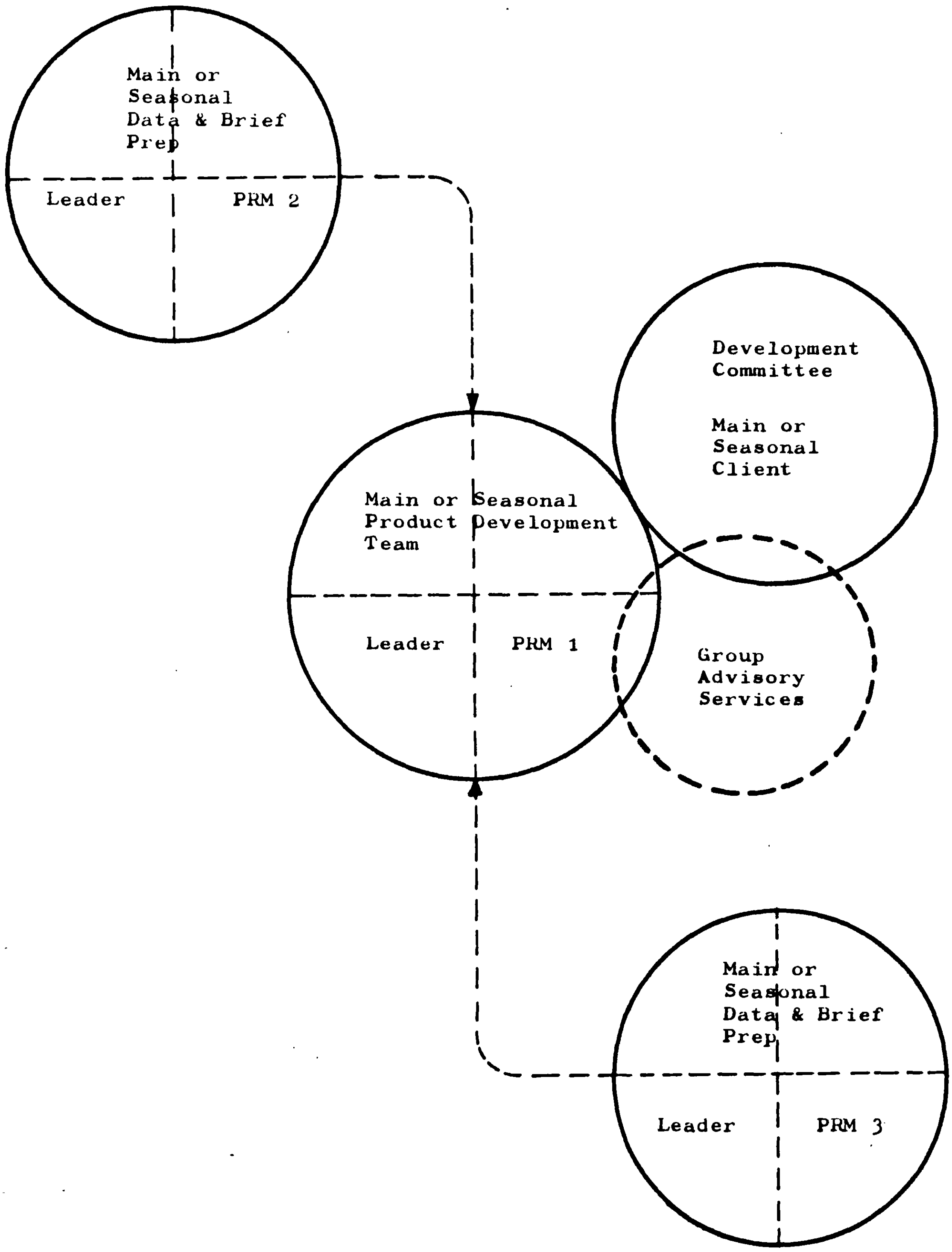
- Access to the group's advisory services as requested by either of the other two parties.

The PDT would also replace the current practice of placing each gender under separate PRM's by contracting to handle the whole season's design and development cycle. Each PRM would, therefore, lead on a basis of rotation, the two not so heavily engaged providing assistance as necessary, whilst making detailed strategy and market preparations for the seasonal or main range collection to follow. Likewise, the majority of review sessions would be located in the PDT, the development committee having fewer meetings, but those remaining acting as watersheds; the PDT having to legitimaze as a group the validity of the solutions presented. Figure 26, illustrates the basis of the concept, which is seen as interactive and in constant rotation.

The system, if sensibly structured with the right people has potential for initiating long term gains in respect of greater accuracy in targeting product policy, capital resourcing or areas of scientific and technical options to assist the recovery of market share. The existing cycle is too reactive, whereas a stronger pro-active stance may encourage resources, such as the group services to be used more imaginatively to solve the problems that are of immediate benefit to the division's health.

As intimated on numerous occasions, an essential aspect of the product cycle is the capability to spot and respond quickly to the changing moods of the market. To realise this damands a sensitive balance between the inner know-

FIGURE 26



THE SYSTEM FOR PDT ROTATION

ledge of received experience and ceative vitality, that can only come through a continuous exposure of external stimuli to the enterprise. It is the formulation of such an approach which is built upon the identified constituent elements of the manufacturing dimension that will, it is hoped, provide the connections to enable the product regain the centre of attention.

Conclusion

The decline of the British manufacturing sector since the end of the 1940's and especially over the last five years, where a further 20 percent collapse has been registered, is frightening to behold. It has defied a never ending stream of analysis produced by government bodies, academics and industrialists, all of whom unite on the central need for manufacturers to concentrate attention on matching products to markets. Vehicle imports rose in May of this year to a staggering 59 percent of the total available market; imports of footwear, the province of case study 'C' currently stand at 42 percent, English cutlery has all but vanished and the indigenous motor-cycle ranks as the latest museum curio. Yet Britain possesses a world wide reputation for the quality of its engineers and industrial designers, many of whom are able to practise their skills successfully in overseas manufacturing concerns, whilst finding it virtually impossible, with some notable exceptions, to make a meaningful contribution in this country.

The field studies have shown that the business of bringing a product successfully from the drawing board to the intended market is more complex than it is often realized, and certainly beyond the capability of the design and engineering functions, if the enterprises's commitment is anything less than total. Despite the obvious and already well documented nature of the above, all three studies portrayed the existence of an invisible barrier at the meeting point of design and production, the former tending to jealously guard professional status from the intrusion of those believed to be on the fringe of the development team, whilst they resented exclusion and the denial of the opportunity to participate in the creation of the product. In addition, the scope of the activities and work covered by the product cycle, irrespective of the technological sophistication, was poorly understood by the participants and managers who devised the organizational system for monitoring the operational matrix. The methods adopted were more reactive than logical, having been clearly designed by personnel who were either constrained within a departmental boundary or had a limited perspective of the product development cycle. In these circumstances, it was hardly surprising to find such universal absence of corporate or stategic thinking with regard to the product's role in the enterprise and lack of an intellectual cutting edge, that characterises the performance of so many imported designs.

It is suspected these observed difficulties, though admittedly based on a very small sample, need to accept a greater level of responsibility than hitherto thought for the loss of market share by Britain's manufacturers. Clearly the standard excuse of the poor utilization of design and engineering capability by industry is a critical factor, but it is not the only one; for if the design and engineering professions cannot bestir themselves and take the initiative and lead, as well as truly join with other disciplines in the sharing of knowledge and effort in servicing the product, then there will be little progress. It does appear reasonable to suggest that those responsible, whoever they are and how numerous, should be entitled to a measure of recognition in respect of authorship as well as the manufactured quality of the end product. In the event of collaboration being ineffective, it is more than likely the design will fail to meet its planned performance targets and instead disappoint, because of some weaknesses, however small, in communications during the development period.

The emergence of a British design profession is a 20th century phenomena, the roots of which are not to be found in any meaningful industrial connection, but primarily with the philosophical teachings of the Arts and Crafts movements. This historical separation from the main stream of everyday life has, unfortunately, tended to give design a quasi fine art status; to a point where companies adjudged by specialists to be making beautiful products are classified as design led, while those offering similar merchandise, but believed to have less visual appeal find themselves labelled as cost, technology or market led. These absurdities, many of which have emanated from official bodies, educationalists and top business executives who see design as a marriage of art to industry, are at last being questioned and not least by those who form the new design consultancies with stock market quotations. Another welcome sign is the work going on in some City Institutions into product forecasting, where the place of the product within the portfolio of the business and the degree of innovatory development for influencing the direction of a market, are assessed well before the results become part of the national accounts. Other pressures for change are coming with the advent of new technologies, where the designer of software programmes for driving new production systems can be as creatively active as those who are responsible for the product or ensure the quality of the end result matches the aspirations of the market place. The question in today's complex manufacturing environment is not so much the employment of a designer or engineer to resolve a product problem, but more to identify who actually designs which part of the product. Clearly the case study findings point to such a dilemma, which the traditional approach to the incorporation of creative activities into manufacturing concerns does not meet. The real difficulty is how to persuade those who are accustomed to holding sole responsibility for product development to relinquish the privilege and interact with other disciplines on a basis of true partnership. As Freeman, Lorenzoni and others have intimated, the ability to construct a listening and catalytic matrix to harness the indigenous capability of a firm, may be one prerequisite which allows creative flair to flourish. It is this balance and the demanded interpersonnel skills, and not the design process or organizational system, that requires further and urgent research.

If Victor Keegan's (26) prognosis is to be believed, and owner occupiers commence switching priorities and make an electronic investment comparable to the owner of a Victorian mill; the level of complexity attached to the design and production of such artifacts can, but only stretch the traditional departmental boundaries to breaking point. If we are unable to evolve new systems which bring together the resources of a manufacturing dimension that recognizes product primacy, than the majority of equipment entering the homes of our internationally aware consumer will come from outside this country. Integrate or die is the name of the game.

Appendices

CASE STUDIES 'A' and 'B' APPENDIX XX

QUESTIONNAIRE

Section 1 - Product Management + Implementation

1.0. Where in your Company's Organisation is product policy determined?

1.1. How long does it take, the number of individuals involved and their job titles.

1.2. What sort of information is provided as input to the planning of product policy?

1.3. Once product policy has been established, how are single design/development projects managed?

List all identifiable steps from authorisation to delivery, including information required and key decision taking points.

1.4. List the three factors which are likely to influence success or failure of design/development projects.

1.5. What criteria governs such decisions?

1.6. What methods have been developed to promote innovation at the design/manufacturing interface?

1.7. How is the Company's management learning to cope with change?

CASE STUDIES 'A' and 'B' APPENDIX XX

QUESTIONNAIRE

Product/Management Implementation

Section 2 - The Product

2.0. What are your Company's products?

2.1. Which single product is the most successful?

Why? (Rank 1 - 10)

2.2. What does the product do?

2.3. Was the product conceived against a brief: how does the manufactured result vary and why did the changes occur?

2.4. Which single decision taken during the design/development phase ensured today's success and what were the reasons or circumstances which led to it?

2.5. How does the product reflect your Company's:

a. Public image.
b. Market position.
c. Innovative capability.
d. Manufacturing resources.
e. Long term Corporate view.

2.6. List three major drawbacks of the product, how long they took to emerge and in what circumstances?

2.7. Taking a similar product from your key competitor, identify three strengths and weaknesses respectively, giving reasons for your choice.

2.8. What product development action is being taken to capitalize upon your competitor's weaknesses?

2.9. Which single product within your range is the least successful?

Why? (Rank 1 - 10)

2.10. What does your job involve?

APPENDIX YY

CASE STUDY 'C'

Interviews - Structured Questionnaire

Summer Seasonal 1984
Slot 14 Group 1
Slot 3 Group 3

1. How did the product come about?

2. What are the key characteristics which need to be achieved?

3. Who are the three key people in the Product Development cycle?

4. Other than the Development Timetable meetings, how do you communicate during the Product Development cycle?

5. What is your role?

6. Who do you report to?

7. Who are your major competitors?

8. How does the Product reflect the Company's:

   - Public image

   - Market position

   - Innovative capability

   - Manufacturing resource

   - Long term corporate view

9. Where in your Company's organization is product policy determined?

10. List the identifiable steps from the point of product release to dispatch from the factory.

APPENDIX ZZ

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October 1981.

LUCAS INDUSTRIES - ANALYSIS OF RESPONSES BY ENGINEERING MANAGERS TO A UNIVERSITY DEVISED PLANNING QUESTIONNAIRE

1.0. Governing Parameters

1.1. The purpose of this further analysis of an analysis already completed by the School of Management was to identify any additional trends which may have a direct bearing on the content of my research study, Innovation and Manufacturing Industry.

1.2. The data for the analysis has been drawn from:

1.2.1. Memorandum from Professor Thomas to Professors, Mangham, Tomkins and Dr. Marshall, dated the 27th April 1981.

1.2.2. Engineering Managers Programme - 1st - 5th June 1981. Note from Dr. D. Findley, Management and Engineering Training Manager, dated the 20th May 1981.

1.2.3. A synopsis of Dr. P. Reasbeck Session "Exploiting New Technologies" which was part of the Engineering Managers Programme, paragraph 1.2.2.

1.2.4. The 13 responses to the University devised Planning Questionnaire.

1.2.5. The School of Management analysis.

1.3. The examination has been conducted purely on the material identified under paragraph 1.2. and three informal discussions held with Professor Thomas. No contact has been made with the respondents, therefore the views expressed are solely based on the above-mentioned written material.

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2.0. Major Objectives

2.1. To clarify the range of comment received from the 13 respondents primarily in the field of product design, research and development or innovation and the position held by these activities, viz-a-viz other management functions.

2.2. To isolate those respondents who have tended to give contradictory answers within the questionnaire with a view to interview for greater clarification.

2.3. To draw any general conclusions.

3.0. The Respondents

3.1. A total of 13 respondents answered the questionnaire. They were drawn from the following Lucas Divisions:

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3.3. All the respondents hold Senior Management positions within the four divisions, job titles include; Product Manager, Engineering Manager, Chief Engineer, Quality Reliability Manager, Tool Provisioning Manager, Principal Engineer and Engineering Services Manager.

3.4. Without making detailed enquiries in respect of paragraph 3.3. it has been assumed from the written material provided that all the respondents are in some way connected with innovation or design functions within their division or group.

4.0. The Planning Questionnaire

4.1. The School of Management devised questionnaire is divided into four interrelated sub-sections, namely:

Planning as a corporate and individual activity.
Planning as it affects product design and innovation.
Planning in anticipation of internal/external trends.
Planning in response to socio-political or techno-economic issues.

4.2. Each sub-section divides into a number of sequential open questions, encouraging respondents to draw upon their background experience for answers.

4.3. As the background of all the respondents is engineering/design, the answers naturally have a tendency to gravitate towards this area of specialism.

5.0. Adopted Method and Terms used in this Analysis

5.1. As already indicated by the School of Management analysis, the diversity of the answers received from the respondents ruled out the possibility of adopting a numerical grading system.

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5.1. (Cont/d)

However, it seemed to be important to attempt some method for establishing common themes, not only from each sub-section, but also from the total questionnaire. In addition to this, a series of sub requirements were felt to be desirable:

a. The respondents attitude as determined by the answers given to the whole range of questions.

b. The identification of individual contradictions.

5.2. To meet these aims it was decided to:

a. Devise an analysis format which would record the views of each respondent by using terminology drawn from their answers against each question.

b. Provide a crude numerical rating to each answer by the number of respondents identifying with it.

c. Extract the two most dominant themes emerging from each question.

d. Group the orientation of the answers under four headings:

Market and Product Development.
Technology & Manufacture.
Organization and Finance.
Environment - Political/Sociological/
Cultural.

e. Collate numerically the frequency of commitment to each of the four groupings.

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5.3. Appendix 'A' lays out the data as suggested by paragraph 5.2.

6.0. Summary of Findings

6.1. Approximately 190 respondent phrases/comments have been extracted from the completed questionnaires and listed under Appendix 'A'. It is believed, subject to some repetition or similar answers to different questions, they represent a fair cross-section of the views expressed.

6.2. Table 1 collates the range of extracted comments under the four category headings already identified under paragraph 5.2. d.

Table 1

Category Headings	Number of recorded comments - less repetition	%
1. Market & Product Development	50	26.3
2. Technology & Manufacture	46	24.2
3. Organization & Finance	56	29.5
4. Environment - Political/Sociological/Cultural	38	20.
Total	190	100%

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6.3. The professional background of the respondents naturally tends to elicit views which are engineering/product dominated. However, it is surprising and of interest that the combined strength of categories 1 and 2 account for just over 50%. whereas finance and organization registers nearly 30%, possibly suggesting a critical awareness.

6.4. The trend is further reinforced when the cumulative support given by respondents to each of the extracts contained by the four categories is calculated - see Table 2.

Table 2

Category Headings	Number of recorded comments - less repetition	%
1. Market & Product Development	134	27.0
2. Technology & Manufacture	105	21.2
3. Organization & Finance	177	35.7
4. Environment - Political/Socio-logical/Cultural	80	16.1
Total	496	100%

6.5. It is accepted a paper analysis such as this (inevitably influenced by subjective interpretation) must draw an inaccurate picture of the situation. Nevertheless, the sheer numerical scale of the extracted comment falling into the organizational category should surely cause concern to those responsible.

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6.6. The perceived communication gap is not solely reserved for unsuccessful divisions within the group. Table 3 examines views drawn from Lucas Girling (successful) and Lucas Electrical (in trouble) all of whom express similar patterns of concern with regard to the organizational environment.

In the case of Lucas Girling, this is unexpected as at the April meeting with the University it was suggested by them "that the programme, whilst it might suit the needs of Lucas Engineering, was of little direct relevance to Lucas Girling - they were in a situation that they had a healthy product position - What was needed in his view was very much better management of people on the part of engineers and this meant having some attempt at the measurement of potential performance and capacity so as to dramatically improve the time performance of engineers on jobs. This was primarily directed at engineers in the design and development stages rather than in the manufacturing stage."

The tenor of the two Girling respondents does not appear to fully square with those expressed by the organization in April last.

6.7. The suggestion of a communications breakdown not only within divisions, but between Group Executive and the divisions is further strengthened, when it is realized that none of the respondents referred to a product policy in corporate terms. They are either, therefore, unaware of its existence or there is no group view, the latter being difficult to comprehend.

TABLE 3

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ANALYSIS OF LUCAS INDUSTRIES RESPONDENTS

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COMPANY	S1	COMMENT	S2	COMMENT	S3	COMMENT	S4	COMMENT
Lucas Electrical		"I have a problem in differentiating between Corporate and Strategic Plan"		"Slow response re prototypes. Dedication by a certain (few) individuals"		"Over capacity for component manufact. Harsher competition Prima Donnas"		"Investment in plant for new processes relating to both existing and new products - Inability to afford effort needed in product/ process development"
Lucas Girling		"Annual Budget. Business Forecasts, longer term Strategic Plans"		"Just about keeping pace with technological and marketing developments"		"New product devel. required at the time of contraction. Productivity not good enough, both labour & technical, junior supervisors are probably our biggest problem"		"Participation, communications, Worker Directors, earlier retirement, acceptance of new technology"
Lucas Electrical		"The aims seem very broad and more occasioned by necessity than foresightedness"		"Decision taking has been slow and laborious in the recently changed Divisional organization"		No responses available		"If we build up technologists to implement change at rate required, what do they do afterwards - risk of over-reaction due to pressure for change"
Lucas Girling		"To go for virtually every opportunity that exists by a Tech. Sales Dept. without any concern for the resources available to support them"		"Every year I am requested to reduce (Development) budgets - I feel that is done by people who have not got any idea as to how it may restrict development of new products - just across the board cut"		"Something better than the 'T' structure"		"Getting 'old hands' to work outside their job spec. without making an excuse for more pay - to be competitive, cost reductions are required on components of identical design to competitors - their product must be more efficient"

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SCHOOL OF MANAGEMENT

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6.8. Table 4 lists the two most dominant themes to emerge against each question posed by all four sessions. A certain consistency pattern can be perceived.

6.8.1. Session 1

- A narrow appreciation of the planning role, no reference to product planning as a policy activity whether based in successful/unsuccessful divisions. As the respondents have an engineering/design background this is clearly puzzling.
- A limited view of the product's central position, only three actually refer to this factor.
- The aims of corporate planning, what and who is involved are poorly understood, "don't knows" being a major common denominator.

6.8.2. Session 2

- Question - "How does your Organization seek to introduce new ideas?" - draws a host of conflicting and in some cases contradictory opinions from the same respondent. However, the priority themes centre around the perceived ineffectiveness of other key disciplines, marketing and finance. The latter keeps cropping up under questions of resistance, inertia, supported by frustration at the adopted decision making process. This trend cuts across all of the divisions sampled.
- Success/failure factors repeat market awareness, plus acute realization that innovation, R. & D., competitiveness, quality and service are core ingredients. Once more the feeling of them (the Management) of having little comprehension of what is involved in the design process permeates the issues raised. This is reinforced by words such as "don't knows, ignored, misunderstood" and the equal split between yeas and nays in respect of whether the information given is cost effective.

TABLE 4

ANALYSIS OF LUCAS INDUSTRIES RESPONDENTS

S1	QUESTION	TWO MOST DOMINANT THEMES	RATING
1	Why Plan?	Lead Time. Cost Control/Manpower/Matching of Resources.	5 4
	What sort of things do you plan?	Engineering/Manufacturing Interface. Design, Tooling, Research, Test.	6 6
2	How does planning as a manager relate to the planning process in the company as a whole?	Evaluation/Screening. Continual modification to priorities.	5 4
3	What are the aims of the Corporate Planning Process in your company?	Maximise company potential. Don't know.	4 3
	What does your C.P. system involve?	Don't know. Strategic planning.	5 3
	Who are involved?	Don't know. General Management.	8 5

TABLE 4

ANALYSIS OF LUCAS INDUSTRIES RESPONDENTS

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S2	QUESTION	TWO MOST DOMINANT THEMES	RATING
1	How does your organisation seek to introduce new ideas and new acquisitions into the system?	Marketing response not fast enough.	10
		Financial Policies restrict growth and enterprise.	9
2	Sort of information provided for C.P.	Customer forward plans.	5
		Resources, Timescale.	5
	How do you believe your information is used?	Planning Resources.	4
		Don't know.	3
	Is provision of information cost effective?	Yes.	7
		No.	6
3	Factors which influence success/failure of project.	Market Awareness.	4
		Innovation, R & D, Competitiveness, quality, service - all rated.	3each
	Strongly developed points of resistance.	Finance/Accountants.	5
		Slow review procedures.	5
	Where are the main points of inertia?	Administration/Finance.	5
		Engineering/Production.	4
	Are you rule bound?	Yes.	6
		Don't know.	4
	Is your decision process slow?	Yes.	7
		Don't know.	3

TABLE 4

ANALYSIS OF LUCAS INDUSTRIES RESPONDENTS

S3	QUESTION	TWO MOST DOMINANT THEMES	RATING
1	List the key trends in the Company's operating environment.	Need for new products. Technological development and standardization.	7 7
2.	List any identifiable internal group currently attempting to effect development of Company Policy.	Trade Unions - Social Products. Computer aided design.	6 4
3.	List any identifiable external groupings currently attempting to effect development of Company Policy.	Customer requirements, government regulations and don't know - all.	3 each
4.	List any internal or external groups you feel the company should influence to secure future and suggest nature of such approaches.	Government and local authorities. Key Suppliers - technical co-operation.	3 3
5.	Identify any coalition of interests amongst the above.	Customer and Regulating Bodies. Product Policy involvement (including Trade Unions).	2 2

TABLE 4

ANALYSIS OF LUCAS INDUSTRIES RESPONDENTS

S4	QUESTION	TWO MOST DOMINANT THEMES	RATING
1.	List the key socio-political issues that are confronting the organizations now.	Redundancy - unemployment.	5
		Environment, pollution, Health & Safety, conservation, Government spending costs - all	3 each
2.	List the emerging socio-political pressures that you foresee for the company within the next 5 - 10 years.	Short working week.	4
		Industrial democracy.	3
3.	List the main techno-economic dilemmas facing your company.	Product development - In-house or Licensing.	5
		Shortage of finance.	5
4.	List the expected techno-economic dilemmas of your company in the next decade.	Acceptance of new technology.	5
		Lack of resources for product development.	2
5.	What coincidences do you find between those listed in questions 1/2 and 3/4?	Technical/Social equation.	4
		Industrial decline.	2

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6.8.3. Session 3/4

- The need for new products linked to technical excellence to meet the challenges of an operating environment dominated by financial constraint, loss of competitive edge, poor productivity and redundancy is given priority.

- Alienation felt by a number of the respondents from the Organization is hinted at by references to the Trade Union alternative product strategy and the belief that greater employee participation will become a prerequisite for future growth and success. Half of those eight who replied to Question 5, Session 4, suggest the technical/social implications equation will be a major problem area in the coming 5 - 10 years.

- However, in the last analysis the answers given to Questions 3/4 are muddled, even if well intentioned and indicate the possible absence of a robust and effectively communicated corporate product philosophy.

6.9. The Group's corporate identity sports a linkage motive. Do the expressed sentiments illustrate a case where corporate identity has become confused with house-style? Wally Olins suggests "a house-style is a graphic design scheme applied to some, most or even all of a company's visible manifestation. House-style to my mind implies a cosmetic job".

6.10. Finally, a number of contradictions are clearly visible, especially in Session 2 where more specific issues are pin-pointed. For instance:

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6.10. a. The Organization keeps pace with technical and market developments, competition not more effective, although they achieve more success with less innovation, own technology is vunerable, do not know how own planning information is used, but is cost effective, no points of resistance, however development samples are difficult to obtain and maybe our manufacturing industry is in decline.

b. The Organization keeps pace with technical and market developments, competitors not more effective but market is R. & D. orientated and current technology is threatened, marketing response not fast enough and financial constraints, information supplied for planning is cost effective, but there are strong points of resistance and decision taking is slow and laborious.

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7.0. Conclusions

7.1. The sample of 13 respondents is small and may be non-representative.

7.2. Some respondents may have misinterpreted the questions and with the aid of a personal interview a modified picture could emerge.

7.3. Allowing for these and other variants, it is submitted there is sufficient evidence to propose that the Group's major problem may not lie so much in its ability to innovate, but more in the Organization's comprehension of the role and position to be held by the engineering/design function within the structure.

7.4. The dominant themes encapsulated by Table 4 illustrate:

a. A deep concern for the product and respect for the performance of competitors.

b. Frustration at not being able to meaningfully influence events within the company or division.

c. A lack of comprehension as to why effective action to combat decline and market share erosion is not considered a top priority.

d. Non-involvement with either the mechanics of determining product direction, policy or detail (witness the high percentage of "Don't knows") or with other specialisms such as marketing or finance.

7.5. Five respondents with a preponderance for contradiction have been isolated and it is believed follow-up interviews to discuss the position of the product within the business would be informative - Draft Questionnaire Appendix B.

APPENDIX A.

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LUCAS INDUSTRIES.

PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 1. PAGE 1

QUESTION. CODE. YES. - ✓. DON'T KNOW - X. NO - O.

RESPONDENTS.

GROUP HEADING ALLOCATION	QUESTION	GROUP 1: J.B.	D.H.	P.B.	K.L.	GROUP 2: R.H.	C.P.	B.G.	J.F.	GROUP 3: M.T.	R.W.	B.N.	R.B.	C.S.	TOTAL	REMARKS
	1.1. WHY PLAN?															
3	A. FINANCE.	✓													1	
3	B. COST CONTROL.	✓						✓			✓		✓		4	
3	C. MANPOWER	✓						✓	✓		✓				4	
2	D. QUALITY CONTROL.	✓													1	
3	E. LEAD TIME.		✓					✓			✓	✓		✓	5	
3	F. DELIVERY		✓								✓				2	
3	G. MATCHING OF RESOURCES + SKILLS.			✓		✓					✓		✓		4	
1	H. RIGHT PRODUCTS, PLACE + PRICE.				✓	✓	✓								3	
2	J. MAINTAIN TECH LEAD.						✓								1	
3	K. OPERATING FRAMEWORK.					✓	✓								2	
3	L. CONSTRAINTS + LIMITATIONS.							✓		✓					2	
3	M. MEASURE PERFORMANCE.									✓		✓			2	
3	N. ANTICIPATION.			✓						✓		✓			3	
3	O. PROFITABILITY.				✓										1	
1	P. RESEARCH.								✓						1	

GROUP HEADING ALLOCATION	QUESTION	GROUP 1: J.B.	D.H.	P.B.	K.L.	GROUP 2: R.H.	C.P.	B.G.	J.F.	GROUP 3: M.T.	R.W.	B.N.	R.B.	C.S.	TOTAL	REMARKS
	WHAT SORT OF THINGS DO YOU PLAN?															
2	A. ENGINEERING / MANUFACTURE INTERFACE.	✓			✓	✓	✓					✓		✓	6	
1	B. NEW PROJECTS. + DEVELOPMENT.	✓	✓												2	
3	C. STRATEGIC PLANNING. DEPT + INDIVID.			✓	✓						✓		✓		4	
1	D. CUSTOMER SUBMISSIONS.				✓										1	
1	E. DESIGN / TOOLING. / RESEARCH TEST.				✓	✓	✓	✓	✓		✓				6	
2	F. ESTIMATES, MATERIALS COSTS, ETC.				✓					✓	✓	✓		✓	5	
3	G. TRAINING	✓				✓						✓			3.	
3	H. MANPOWER.					✓	✓						✓	✓	4	
2	J. TECHNOLOGICAL DEVELOPMENT.						✓								1	
3	K. MEETINGS.								✓						1	
3	L. AVAILABILITY. - DELIVERY.									✓					1	
2	M. DATA SYSTEMS.												✓		1	

GROUP HEADING ALLOCATION	QUESTION	GROUP 1: J.B.	D.H.	P.B.	K.L.	GROUP 2: R.H.	C.P.	B.G.	J.F.	GROUP 3: M.T.	R.W.	B.N.	R.B.	C.S.	TOTAL	REMARKS
	2. HOW DOES PLAN AS MANAGER RELATE TO PLAN PROCESS IN CO. AS WHOLE?															
2	A. ENGINEERING / MANUFACTURE INTERFACE.	✓								✓					2	
1	B. CUSTOMER RELATED PROJECTS.		✓												1	
3	C. DEPARTMENTAL NEEDS.			✓											1	
3	D. IMMEDIATE PRIORITIES - OF COURSE.			✓	✓				✓		✓				4	
3	E. PROCEDURES.				✓			✓			✓				3	
1	F. BOTTOM UP MARKET AND TECH ASSESS.					✓						✓	✓		3	
2	G. DESIGN + MANUFACTURING OBJECTIVES.						✓								1	
1	H. PRODUCT PLANNING + DEVELOPMENT.							✓	✓				✓		3	
1	J. EVALUATION / SCREENING.	✓				✓		✓		✓		✓			5	
3	K. FUTURE PROFITABILITY.											✓			1	
3	L. TO CO. NOT SURE GROUP?.													✓	1	

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APPENDIX A.

STUDENT. R.J. METCALFE. MSc BY RESEARCH. UNIVERSITY OF BATH. SCHOOL OF MANAGEMENT.

LUCAS INDUSTRIES.

PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 1 PAGE 2.

QUESTION. CODE. YES. - ✓. DON'T KNOW - X. NO - O.

GROUP HEADING ALLOCATION	QUESTION	GROUP 1.	J.B.	D.H.	P.B.	K.L.	GROUP 2	A.H.	C.P.	B.G.	J.F.	GROUP 3.	M.T.	R.W.	B.N.	R.B.	C.S.	TOTAL ✓	RESPONSES.
	3. WHAT ARE THE AIMS OF THE CORPORATE PLANNING PROCESS IN YOUR COMPANY?																		
3	A. CO-ORDINATION +		✓															1	
3	B. COMMON OBJECTIVES.		✓															1	
2	C. MAXIMUM PRODUCTIVITY FROM EACH UNIT.			✓														1	
3	D. MAXIMISE PROFITABILITY.				✓	✓												2	
3	E. MAXIMISE COMPANY POTENTIAL.				✓	✓									✓	✓		4	
1	F. PRODUCT EXPANSION - DIVERSIFICATION.							✓										1	
3	G. PANIC IN PLACE OF ANTICIPATION.								✓									1	
4	H. DON'T KNOW.									✓				✓		✓		3	
3	J. SALES ORIENTATION - NO CONCERN FOR BACKUP RESOURCES.										✓							1	
4	K. CAUTION, PRUDENCE.												✓					1	
3	L FINANCIAL.														✓			1	
4	M. SURVIVAL.														✓			1	
1	N. RIGHT PRODUCTS, TIME AND PRICE.																✓	1	
	WHAT DOES YOUR C.P. SYSTEM INVOLVE?																		
3	A. BUDGET + BUSINESS FORECASTS.		✓												✓			2	
3	B. STRATEGIC PLANNING.		✓												✓		✓	3	
1	C. SURVEYING CUSTOMER PROSPECTS.			✓														1	
2	D. RECOMMENDATIONS - NEW - TECH.				✓													1	
4	E. DON'T KNOW.					✓			✓	✓				✓			✓	5.	
1	F. CUSTOMER / COMPANY FEEDBACK.							✓										1	
3	G. EVALUATION. LOCAL THEN MAIN BOARD.												✓					1	
3	H RESOURCE AVAILABILITY.							✓			✓							2	
1	J. DESIGN / PRODUCTION / MARKET PLANNING.															✓		1	
	WHO ARE INVOLVED?																		
2	A. ENGINEERS (DESIGN + MANUFACTURE)		✓					✓			✓					✓		4	
1	B. SALES.		✓					✓										2	
2	C PRODUCT MANAGERS.		✓	✓														2	
3	D. ACCOUNTANTS.		✓					✓					✓					3	
3	E. PERSONNEL.							✓										1	
3	F. GENERAL MANAGEMENT.							✓	✓				✓		✓	✓		5	
3	G. GROUP OPERATIONS DIRECTOR.							✓					✓		✓			3	
3	H. EXECUTIVE.								✓									1	
2	J. CHIEF ENGINEER + DIRECTOR.										✓							1	
1	K. MARKETING MANAGER.										✓							1	
2	L SITE MANAGER.												✓					1	
4	M. DON'T KNOW.			✓	✓	✓			✓	✓				✓		✓	✓	8	

TOTALS.
1. 16
2. 14
3. 37
4. 5.

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APPENDIX A. | UNIVERSITY OF BATH.
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LUCAS INDUSTRIES.

PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 2 PAGE 1

QUESTION. CODE. YES. - ✓. DON'T KNOW. X. NO. O.

Group heading allocation	Question	Group 1. J.B.	D.H.	P.B.	K.L.	Group 2. R.H.	C.P.	B.G.	J.F.	Group 3. M.T.	R.W.	B.N.	R.B.	C.S.	Total ✓	X	O
2.	1. A. ORGANIZATION NEEDS MADE WITH TECH AND MARKET DEVEL.	X	✓/O	O	X	✓/O	O	✓	✓	O	O	✓	✓/O	O	3	4	5.
1.	B. COMPETITORS MORE EFFECTIVE IN NEW PROD. DEVEL.	X	O	✓	✓	✓/O	✓	✓	O	✓	✓	O	✓/O	✓/O	6	4	2
1.	C. MARKET R+D DETERMINED.	X	✓	✓	✓	✓	✓	✓	O	X	X	✓	X	✓	8	4	1
2.	D. PRESENT TECH VULNERABLE.	O		✓			✓	✓	X	✓	✓	✓	X	✓	7	2	1
1.	E. MARKETING RESPONSE FAST ENOUGH.		O	O	O	O	O		✓	O	O	O	O	O	1	-	10
3.	F. FINANCIAL POLICIES RESTRICT GROWTH AND ENTERPRISE.			✓	✓	✓	✓/O	O	✓	✓	✓	✓	✓	✓	9	1	1
	2 SORT OF INFORMATION PROVIDED FOR CORPORATE PLANNING.																
2	A. PROD. ENGINEERING - TOOL DES.	✓								✓				✓	3		
1.	B. CUSTOMER FORWARD PLANS.		✓	✓		✓					✓			✓	5		
2	C. TECHNICAL ADVANCES, ETC.			✓							✓				2		
1.	D. PERFORMANCE / PRICE.					✓							✓		2		
3	E. RESOURCES. TIMESCALE, ETC.			✓	✓		✓	✓				✓			5.		
3	F. COST ESTIMATES.							✓	✓	✓		✓			4		
2	G. QUALITY + RELIABILITY DATA.								✓				✓		2		
	HOW DO YOU BELIEVE YOUR INFORMATION IS USED.?																
1.	A. DETERMINE CUSTOMER NEEDS.		✓			✓									2		
3	B. PLANNING RESOURCE.			✓	✓	✓					✓				4		
3	C. RECOVERY FORECASTING.						✓								1		
3	D. IGNORED OR MISUNDERSTOOD.					X			✓		✓				2	1	
3	E. OVERHEAD ESTIMATES.									✓					1		
3	F. FINANCIAL CONTROL.											✓			1		
3.	G. DON'T KNOW.							✓					✓	✓	3		
3.	IS PROVISION OF INFORMATION COST EFFECTIVE.?	✓	✓	X	✓	✓	X	✓	X	✓	X	✓	X	X	7	6	
	3. FACTORS WHICH INFLUENCE SUCCESS / FAILURE OF PROJ.																
1.	A. MARKET AWARENESS.	✓	✓						✓					✓	4		
1.	B. RESOLUTION - LACK			✓								✓			2		
3.	C. SLOW RESPONSE.				✓		✓								2		
2	D. QUALITY + SERVICE.				✓					✓		✓			3		
1.	E. INNOVATION, R+D.				✓	✓								✓	3		
1.	F. COMPETITIVENESS.					✓		✓				✓			3		
3	H. IDENTIFICATION OF PRIORITIES.								✓						1		

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APPENDIX A. UNIVERSITY OF BATH.

STUDENT. R.J. METCALFE. MSc BY RESEARCH. SCHOOL OF MANAGEMENT.

LUCAS INDUSTRIES.

PLANNING QUESTIONNAIRE. – ANALYSIS. SESSION. 2 PAGE. 2

CODE. YES. – ✓. DON'T KNOW · X. NO · O.

GROUP HEADING ALLOCATION	QUESTION	GROUP 1	J.B.	D.H.	P.B.	K.L.	GROUP 2	A.H.	C.P.	B.G.	J.F.	GROUP 3	M.T.	R.W.	B.N.	R.B.	C.S.	TOTAL ✓	X	O
	3. STRONGLY DEVELOPED POINTS OF RESISTANCE.																			
3	A. SLOW REVIEW PROCEDURES.			✓	✓	✓			✓								✓	5		
2	B. PROTOTYPE DEVELOPMENT.					✓												1		
3	C. ACCOUNTANT'S VIEW.							✓										1		
3	D. LIMITED BUDGET.					✓		✓			✓		✓				✓	5		
3	E. TOO MANY COOKS.															✓		1		
	F. PRODUCTION.																			
3.	G. YES/NO.		✓							O				X	✓			2	1	1
	WHERE ARE THE MAIN POINTS OF INERTIA?																			
2	A. ENGINEERING / PRODUCTION.		✓			✓				✓	✓							4		
3	B. ADMINISTRATION.			✓	✓				✓							✓	✓	5		
1.	C. RESOLUTION. - LACK:							✓		✓								2		
3	D. GROUP DIRECTOR OR SENIOR EXECUTIVE LEVEL.												✓		✓			2		
3.	ARE YOU RULE BOUND?		O	✓	✓	X			✓	X	✓		✓		✓ X	X	✓	6	4	1
3.	IS YOUR DECISION PROCESS SLOW?		X	✓	✓	X			✓	O	✓		✓		✓	X	✓	7	3	1.

TOTALS.
1. 11.
2. 8.
3. 21.
4. –

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GROUP HEADING ALLOCATION

APPENDIX A.

STUDENT. R.J. METCALFE. MSc BY RESEARCH. UNIVERSITY OF BATH. SCHOOL OF MANAGEMENT.

LUCAS INDUSTRIES.

PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 3 PAGE. 1.

Group heading allocation	QUESTION. CODE. YES. - ✓. DON'T KNOW - X. NO - O.	GROUP 1.	J.B.	D.H.	P.B.	K.L.	GROUP 2	R.H.	C.P.	B.G.	J.F.	GROUP 3.	M.T.	R.W.	B.N.	R.B.	C.S.	✓ TOTAL	PRIORITIES
	1. LIST THE KEY TRENDS IN THE COMPANY'S OPERATING ENVIRONMENT.																		
2	A. OVER CAPACITY.		✓	✓		✓												3	
1.	B. LOSS OF COMPETITIVENESS.		✓			✓		✓					✓		✓			5	
2	C. POOR PRODUCTIVITY - TECH + SHOP FLOOR.		✓			✓					✓		✓		✓	✓		6	
4	D. REDUNDANCY.		✓								✓					✓		3	
1.	E. NEW PRODUCTS NEEDED AT A TIME OF CONSTRAINT.		✓	✓	✓			✓		✓					✓	✓		7	
1.	F. MARKET CHANGES.			✓				✓										2	
3	G. RISK SHARING.				✓									✓				2	
4	H. CONSERVATION.				✓	✓									✓			3	
2	J. NEW TECHNOLOGICAL DEVEL. AND COMPONENT STANDARDISATION.			✓	✓			✓			✓			✓	✓	✓		7	
2	K. NEED FOR CAD, DATA LOGGERS, ETC.										✓							1	
1.	L. DEVELOPE NEW OUTLETS, EXPORTS.										✓		✓	✓		✓		4	
2	M. FLEXIBLE TECHNICAL RESPONSE.			✓											✓			2	
	2. LIST ANY IDENTIFIABLE INTERNAL GROUPS CURRENTLY ATTEMPT AFFECT DEVEL. OF COMPANY POLICY.																		
4	A. TRADE UNIONS. + SOCIAL PROD.		✓		✓	✓		✓		✓				✓				6	
4	B. JUNIOR SUPERVISORS - PRODUCTION.		✓															1	
3	C. TECH ADMIN GROUP FORMED PROG. NEW CUSTOMER PROJECTS			✓														1	
2	D. COMPUTER GROUPS TO AID R+D.			✓	✓					✓				✓				4	
1.	E. PROJECT POLICY GUIDE - MONTHLY MEETING.				✓	✓									✓			3	
4	F. PRIMA DONNAS.					✓												1	
1.	G. PRODUCT DEVEL. TEAMS.									✓								1	
3.	H. T. STRUCTURE POOR MOTIVATOR.										✓							1	
3.	J. DON'T KNOW.												✓	✓				2	
2	K. QUALITY GROUPS.														✓			1	
3	L. FEWER KEY PEOPLE IN DECISION MAKING.															✓		1	

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EXPERT HEADING ALLOCATION.

APPENDIX A. UNIVERSITY OF BATH.
STUDENT. R.J. METCALFE. MSc BY RESEARCH. SCHOOL OF MANAGEMENT.

LUCAS INDUSTRIES.
PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 3. PAGE 2

QUESTION. CODE. YES. - ✓. DON'T KNOW · X. NO · O.

RESPONDENTS.

Heading allocation	Question	Group 1 J.B.	D.H.	P.B.	K.L.	Group 2 R.H.	C.P.	B.G.	J.F.	Group 3 M.T.	R.W.	B.N.	R.B.	C.S.	Total ✓ responses
	3. LIST ANY IDENTIFIABLE EXTERNAL GROUPINGS CURRENTLY ATTEMPT TO AFFECT LEVEL OF COMPANY POLICY.														
4.	A. ENVIRONMENTAL LEGISLATION.	✓	✓												2
1.	B. COMPETITORS.			✓											1
1.	C. CUSTOMER REQUIREMENTS.			✓	✓			✓							3
1.	D. CONSUMER PRESSURE GROUPS.				✓										1
4.	E. GOVERNMENT REGULATIONS.				✓			✓			✓				3
1.	F. GOVERNMENT R+D ESTABLISHMENTS.					✓									1
2.	G. ENERGY CONSERVATION.								✓						1
3.	H. DON'T KNOW.									✓	✓		✓		3
	4. LIST ANY INT OR EXT GROUPS YOU FEEL THE COMPANY SHOULD INFLUENCE TO SECURE FUTURE AND SUGGEST NATURE OF SUCH APPROACHES.														
4.	A. WELSH DEVEL AGENCY.	✓													1
4	B. GOVERNMENT + LOCAL AUTHORITIES.	✓			✓			✓							3
4	C. UNIVERSITIES, POLY, ETC.	✓													1
4	D. ENERGY RESOURCE BODIES.		✓												1
1.	E. EUROPEAN COUNTERPARTS TO CONTAIN IMPORT THREAT.			✓	✓										2
3.	F. UNIONS.					✓									1
4	G. PUBLIC INDUSTRIES B.R. GAS. ETC.					✓									1
1.	H. KEY SUPPLIERS - TECH CO-OPERATION.								✓			✓	✓		3
1.	J. CONSUMER + MARKET RESEARCH.									✓	✓				2
	5. IDENTIFY ANY COALITION OF INTERESTS AMONGST THE ABOVE.														
1.	A. CUSTOMERS + REGULATING BODIES.				✓				✓						2
1.	B. PRODUCT POLICY GROUP + TRADE UNIONS.				✓	✓									2
3.	C. PRODUCT POLICY GROUP + FINANCIAL INSTITUTIONS.				✓										1
1.	D. PRODUCT POLICY GROUP + PARTNERSHIPS.				✓										1
1.	E. MARKET + DESIGN + MANUFACTURE.									✓					1
1.	F. COMPANY MIDDLE MANAGEMENT + CUSTOMER LIAISON.												✓		1

TOTALS.
1. 18.
2. 8.
3. 8.
4. 12.

DATE. - OCTOBER 1981.

APPENDIX A. UNIVERSITY OF BATH.

STUDENT. R.J. METCALFE. MSc BY RESEARCH. SCHOOL OF MANAGEMENT.

LUCAS INDUSTRIES.

PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 4 PAGE. 1.

CODE. YES - ✓. DON'T KNOW - X. NO - 0.

GROUP HEADING ALLOCATION	QUESTION.	GROUP 1.	J.B.	D.H.	P.B.	K.L.	GROUP 2	R.H.	C.P.	B.G.	J.F.	GROUP 3	M.T.	R.W.	B.N.	R.B.	C.S.	✓ TOTAL RESPONSES.
	1. LIST THE KEY SOCIO-POLITICAL ISSUES THAT ARE CONFRONTING ORGANISATION NOW.																	
3	A. ALL LEVEL PARTICIPATION - IND REL.		✓												✓			2
4	B. HEALTH + SAFETY.		✓	✓							✓							3
4	C. THE ENVIRONMENT. POLLUTION.			✓		✓									✓			3
4	D. CONSERVATION.				✓	✓									✓			3
4	E. WAGE EXPECTATIONS, UNIONISATION.				✓													1
2	F. SKILL DIVERSIFICATION.				✓													1
4	G. REDUNDANCY UNEMPLOYMENT.					✓			✓		✓		✓			✓		5.
4	H. GOVERNMENT SPENDING CUTS.							✓	✓					✓				3
4	J AGE EMPLOYEE GROUPS IMBALANCE.									✓								1
3	K. POOR MOTIVATION.									✓	✓							2
2	L. COMPUTER AIDED MANUFACTURE.												✓					1
4	M. OVER MANUFACTURING CAPACITY WITHIN DEVELOPED WORLD.															✓		1
	2. LIST THE EMERGING SOCIO-POLITICAL PRESSURES THAT YOU FORSEE FOR THE COMPANY WITHIN NEXT 5-10 YEARS.																	
4	A. INDUSTRIAL DEMOCRACY. W. DIRECTORS.		✓		✓										✓			3
4	B. SHORTER WORKING WEEK.		✓		✓	✓									✓			4
4	C. EARLY RETIREMENT.		✓			✓												2
1	D. CONSUMER PRODUCT REGULATION.			✓														1
2	E. MANUFACTURING CONTRACTION.					✓												1
2	F. COMPUTER AIDED DES + MANUF.					✓							✓					2
4	G. WELFARE STATE CONTRACTION DUE TO LACK OF FUNDS.								✓									1
4	H. WEALTH RE-DISTRIBUTION.								✓									1
2	J. LOSS OF SKILL EXPERIENCE.				✓					✓								2
2	K. 5-6 CAR MANUFACTURERS WORLD WIDE.															✓		1
4	L. THIRD WORLD ECONOMIC DEVELOPMENT.															✓		1
4	M. HIGH TECHNOLOGY PRIORITY FOR DEVEL. WORLD.															✓		1

DATE. - OCTOBER 1981.

APPENDIX A. UNIVERSITY OF BATH.
STUDENT. R.J. WHITEHOUSE(?). MSc BY RESEARCH. SCHOOL OF MANAGEMENT.

LUCAS INDUSTRIES.
PLANNING QUESTIONNAIRE. - ANALYSIS. SESSION. 4 PAGE 2

CODE: YES - ✓. DON'T KNOW - X. NO - O.

GROUP HEADING ALLOCATION	QUESTION	GROUP 1	J.B.	O.H.	P.B.	K.L.	GROUP 2	R.H.	C.P.	B.G.	J.F.	GROUP 3	M.T.	R.W.	B.N.	R.B.	C.S.	✓ TOTAL RESPONSES
	3. LIST THE MAIN TECHNO-ECONOMIC DILEMMAS FACING YOUR COMPANY.																	
4	A. PRODUCTIVITY - UNEMPLOYMENT.		✓															1
3	B. CENTRALISATION - DECENTRALISATION.		✓															1
2	C. HIGH TECH - HIGH COST EQUATION.			✓		✓		✓										3
1	D. IN HOUSE OR LICENSING PRODUCT DEVELOPMENT.				✓	✓				✓			✓		✓			5
2	E. INVESTMENT IN CAD/CAM.				✓													1
1	F. INABILITY TO AFFORD PRODUCT/PROCESS DEVELOPMENT.					✓		✓					✓					3
2	G. COMPUTER SOFTWARE CAPABILITY.							✓										1
2	H. LACK OF TECHNOLOGISTS.								✓									1
1	J. OVERSEAS COMPETITION. MARKET LOSS.									✓	✓			✓		✓		4
1	K. IMPROVED PRODUCT LIFE/QUALITY.										✓							1
2	L. INABILITY TO PRODUCE + DELIVER EFFECTIVELY.													✓				1
3	M. SHORTAGE OF FINANCE.								✓				✓	✓	✓	✓		5.
	4. LIST THE EXPECTED TECHNO-ECONOMIC DILEMMAS OF YOUR COMPANY IN THE NEXT DECADE.																	
2	A. ACCEPTANCE OF NEW TECH.		✓			✓		✓	✓						✓			5
2	B. ENERGY SCARCITY.			✓														1
4	C. AUTOMATION - UNEMPLOYMENT.				✓													1
2	D. MICRO ELECTRONIC DEVELOPMENTS.				✓													1
1	E. NEW PRODUCT DEVELOPMENT - LACK OF CASH RESOURCES.					✓					✓							2
1	F. PURCHASE OFF THE SHELF R+D.							✓										1
2	G. OVER REACTION TO NEW TECH - REDUNDANT TECHNOLOGISTS.								✓									1
1	H. LACK OF PROD DEVEL - DECLINING									✓	✓							2
	INDUSTRY + MARKET.													✓				1
2	J. RAW MATERIAL PRICE INCREASES.										✓							1
1	K. NEED FOR EXPORT ORIENTATION.													✓				1
	5. WHAT COINCIDENCE DO YOU FIND BETWEEN THOSE LISTED IN QUESTIONS 1/2 AND 3/4.																	
4	A. TECHNICAL/SOCIAL EQUATION.			✓	✓						✓		✓					4
3	B. FINANCIAL RESOURCES/SOCIAL EXPECTANCY EQUATION.								✓									1
4	C. INDUSTRIAL DECLINE.					✓				✓								2
4	D. PEOPLE/WILLINGNESS TO CHANGE.														✓			1

TOTAL. 1. 9
2. 16
3. 5
4. [illegible]

DATE. - OCTOBER 1981.

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