MAKING AND IMPLEMENTING

INDUSTRIAL BUILDING INVESTMENT DECISIONS

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ABSTRACT

This thesis aims to increase current understanding of the ways in which large firms make and implement industrial building investment decisions. The study reported involved an investigation, from the corporate perspective, of the decision and implementation stages of capital investment projects in two large UK firms.

The orientation of the study is towards a consideration of investment decision making and implementation as a problem for management involving a process of resource allocation occurring over time and throughout the corporate organisation. Drawing on research in the business administration area of social science, the process model of resource allocation by Bower (1970) is used as a conceptual framework and to suggest propositions for study which direct attention at key features of the process.

By viewing corporate capital investment decision making and implementation within this framework - and as part of an in-depth, case-based, exploratory research strategy - rather than in terms of its financial or economic consequences, the study reaches an understanding of the ways in which both firms studied actually made and implemented their capital investment decisions. The analysis utilised the study propositions to explore the resource allocation process and yields important observations on the role of the construction industry in the investment decision process and of the role of the corporate client in the construction process.

The central finding is that the implementation of corporate capital investment, seen from the firm's perspective, is more a continuation of the process of capital investment than an end result of it. The study suggests that the construction industry participates rather more in the investment decision process, and the corporate client participates rather more in the construction process, than is generally recognised in the literatures on corporate capital investment and construction management.

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CONTENTS

Appendices (cont'd)

LIST OF FIGURES

ACRONYMS

AFV	Armoured fighting vehicle
BC	Barnard Castle
CAOS	Cefuroxime axetil for oral suspension
CAR	Capital appropriations request
CMC	Cephalosporins Manufacturing Centre (Glaxo)
DCC	Development Co-ordination Committee (Glaxo)
DP	Development Project (Glaxo)
DPC	Development Policy Committee (Glaxo)
EI	Employer's Instruction
FDA	Food and Drug Administration
GGR	Glaxo Group Research
GMS	Glaxo Manufacturing Services
GP&ES	Glaxo Production and Engineering Services
GTC	Group Technical Committee (Glaxo)
HDPE	High density polyethelyne
HVAC	Heating ventilation and air conditioning
IRD	International Registration Dossier
JCT	Joint Contracts Tribunal
MBT	Main battle tank
MCV	Mechanised combat vehicle
M&E	Mechanical and electrical installations
NDA	New Drug Application
PLA	Product License Application
RAPEI	Request for approval of Employer's Instruction
RO	Royal Ordnance
ROI	Return on investment
RoW	Rest of the world
R&D	Research and Development
SLS	Sodium laryl sulphate (added to CAOS to improve granulation)
SPU	Strategic Planning Unit (Glaxo)
TDD	Technical Development Directorate (Glaxo)
tpa	Tonnes per annum
TWP	Technical Working Party (Glaxo)
UK	United Kingdom
USA	United States of America
VDS	Vickers Defence Systems

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION: PROBLEM AND FOCUS

1.1.1 The role of corporate capital Investment

Corporate capital investment is an important element in the economic growth of individual firms and of the wider economy. It is important also for the construction industry, as a significant proportion of corporate capital investment is devoted to buildings. This varies between individual firms and between industries, but on average UK firms allocated about 25 per cent of capital investment resources to new building work in 1991[1]. This accounts for a relatively large proportion of total new construction output, amounting to more than 50 per cent that year[2].

As a subject for study, corporate capital investment occupies a central position in the microeconomic theory of the firm and in theories of finance and corporate strategy. It also features prominently in a public policy context where assumptions about the determinants of investment underpin policies aimed at managing the economy as a whole[3]. In recent years much theoretical and empirical attention has been devoted to consideration of the choices and decisions of individual firms in the allocation of investment funds. However, in many cases the line of enquiry leaves off where the investment decision ends. The question of how corporate decisions to invest in physical assets are implemented has been less well explored. More specifically, relatively little consideration has been given in research to the process by which firms implement building investment decisions.

1.1.2 Outline problem statement

Two problems in particular for the firm's management help bring into sharper focus the issues to be investigated. The first concerns the involvement of the construction industry in the capital investment process. Construction's role is traditionally seen in terms of implementing that part of the investment decision involving building work. However, by providing concepts, plans, programmes, etc, on which the costs of the investment project are based, construction participates in the process long before implementation begins. How the firm manages this contribution has not, as far as is known, been explored in the context of the firm's capital investment process.

The second concerns the involvement of the firm's management as corporate client in the construction process. During construction, the firm's requirements may change such that the building originally conceived is no longer suitable. The key question for the firm's management is then: "How do we ensure that we get the building we need?".

1.1.3 Focus and perspective

The central thesis to be developed in this study is that implementation is a part of the process of capital investment, and not simply an end result of it. The argument is developed more fully below and in chapters 2 and 3 but is asserted for now to help put what follows in context.

The research reported examines how corporate building investment decisions are made and implemented. Its primary focus is on the large manufacturing firm investing in a new factory for its own use. The study takes as its starting point the manufacturing firm's need for a new factory and, from that perspective, seeks to examine how the firm obtains a suitable building. In doing so it draws on recent work in the business administration area of social science which examines the capital investment process in terms of its organisational and political aspects rather more than its economic or financial ones (for a summary, see Marsh *et al*, 1988). The analysis yields observations on the corporate client's role in factory building projects and a conceptual framework by which this role may be examined.

1.1.4 Points of departure

This work spans a number of academic disciplines. It does not, however, address the central concerns of all of them. In an ultimate sense it is about the behaviour of people in organisations and about personal and entrepreneurial motivation. It does, however, have a more specific purpose.

By exploring the corporate client's role in building procurement as part of the capital investment process it signals a point of departure from many theoretical treatments of capital investment. These not only ignore the construction contribution, but consider implementation as an outcome of a decision to invest. It will be argued that the data presented later in this thesis indicate that the investment and implementation processes are not so easily separated.

The firm's perspective is taken in the belief that it will provide valuable new insights into the building procurement and management process. By concentrating on the corporate client's role, this study departs significantly from previous work in the area of building procurement and management which has tended to concentrate on the points of view of the property and construction industries.

The next section provides an introduction to the theoretical and empirical foundations of the present research (which are considered in more detail in chapter 2). This includes a discussion of the rationale for the focus and perspective taken. It is followed by sections on the research design, the research territory and the structure and outline of the remainder of the thesis.

1.2 FOUNDATIONS OF THE PRESENT RESEARCH

The present research arises from a number of distinct but related lines of enquiry concerning:

1. corporate capital investment;
2. organisational behaviour and decision making;
3. building procurement and management; and
4. factory buildings as inputs to production.

1.2.1 Purpose and process in corporate capital investment

The central problem of investment is how best to allocate the resources available; in essence the "economic problem"[4]. Whether to further the wealth of nations or of individuals, the efficient allocation of resources has been the subject of serious enquiry for a considerable time.

Attention has also focused on the investment decisions of firms. A good deal of this has arisen from a long standing interest in the determinants and outcomes of investment so as to refine prescriptive theories of economic choice (Copeland and Weston, 1983). Trends towards increasing industrial concentration in the latter half of this century (Hannah, 1983) have been accompanied by a growing awareness of and interest in the administrative aspects of organisations (Simon, 1945). The decision processes of large firms in particular have thus attracted considerable attention in recent years.

1.2.2 A conflict of paradigms

While research has examined both the motivation[5] for, and the process[6] of corporate capital investment, analysis has taken a number of perspectives: financial, economic, organisational and behavioural. Different approaches have, not surprisingly, been unable to reach a consensus about either purpose or process. What is more surprising, however, is the intractability of many of the questions raised and solutions offered, particularly when viewed across academic disciplines.

In particular, theories of corporate finance and microeconomics, partly to facilitate economic analysis, make assumptions about the nature and location of corporate capital investment decisions: in short, such decisions consist of rational choices between investment alternatives made by top management (Bierman and Smidt, 1988). On the other hand, empirical studies of the process in the business administration area have evolved from a growing awareness of the firm as a political organism and from a view of man within administrative organisation[7]. These locate investment choices with personnel lower down the management hierarchy and emphasise the political and organisational context as being of crucial importance[8].

This apparent conflict has provided fruitful topics for scholarly enquiry in a variety of disciplines. Its currently unresolved status suggests the need for further study. However, such lack of resolution is not particularly conducive to prescription, which may help explain why the building management and procurement literature has virtually ignored this conflict up to now[9].

1.2.3 Capital investment and building procurement

The question of how building investment decisions are implemented is largely absent from the literature on capital investment decision making. Moreover, it will be argued that the construction procurement and management literature also pays relatively little attention to the construction process as a continuation of a capital investment decision. This is primarily because it lacks both a focus on the client's perspective and a consideration of the corporate client as a complex organisation operating in a dynamic and changing business environment.

First, although there is considerable emphasis within this literature on the early stages of the construction process, these are rarely seen from the client's perspective or as part of the capital investment process. The literature on briefing, for example, tends to be prescriptive and to focus on problems facing building designers rather than on the problems clients may have in identifying and articulating their requirements (Kelly *et al*, 1992). This issue is returned to in chapter 2.

Secondly, research in building management and procurement has only recently begun seriously to look at why and (to a far lesser extent) how firms invest in new buildings[10]. A large body of the literature effectively ignores any consideration of the corporate client as an organisation and the closely related issues of managerial and administrative behaviour. Indeed, the dominant tradition in this literature has included the implicit assumption that corporate clients behave much like rational individuals and that, as in conventional finance and economic theory, investment decision making is vested in top management[11]. In particular, the implications for construction of the findings of empirical research into the process of capital investment within construction's corporate client organisations remain unexplored.

1.2.4 The focus on manufacturing firms building new factories

The large manufacturing firm investing in new factory buildings for its own use provides a useful focus for exploring some of these questions for the following reasons.

First, much of the empirical research into corporate capital investment in recent years has focused on the investment decisions of large firms procuring production facilities for their own use (for example, Bower, 1970; King, 1975; Marsh *et al*, 1988). Little attempt has been made up to now to explore the implications of this recent work for project implementation and building procurement. As the nature of the present study is essentially exploratory (see below and chapter 4), it would be premature to begin such an exploration in other than manufacturing industry.

Secondly, the large firm is now the dominant instrument for the production of goods all over the developed world. Little consideration has been given in construction research to the large firm as construction client.

Thirdly, the contribution of industrial building investment to the well-being and international competitiveness of UK manufacturing industry has been debated within both the construction and manufacturing industries for some time (Institute of Directors, 1962; Drury, 1981; Industrial Building Bureau, 1984).

And fourthly, factory buildings have a particular status in orthodox economic theory as inputs to production[12]. While the central concern of investment may be economic, this research and its methodology are more concerned with capital investment and implementation as processes involving the interaction of people and information which require to be managed. Furthermore, the concern is with the process of building procurement rather than the inherent nature of factory buildings.

Nevertheless, consideration of how firms acquire new factory buildings as portrayed within microeconomic theory raises important questions for the corporate client's role in the construction process. For this reason the nature of factory buildings is discussed briefly below.

1.2.5 The particular nature of factory buildings

The treatment of factory buildings as factors of production is somewhat problematic within microeconomic theory. Manufacturing firms require land and buildings, labour, machinery and financial capital for the production of goods, but economic theory does not deal specifically with how firms acquire that factor of production represented by buildings. In orthodox microeconomics, buildings fit into the production process like any other factor of production: in the profit maximising firm additional buildings will be taken on until their marginal productivity equals their marginal cost (Curwen, 1974; Crew, 1975).

However, Fothergil *et al* (1987) argue that the particular nature of factory buildings means that, unlike other production factors such as labour and machinery, these "smooth marginal adjustments" implied by theory are not possible in the case of buildings. This is because buildings are relatively indivisible, so that physical constraints of site, building form, technology and so on constrain the extent to which buildings may be continually adjusted in line with changing production requirements[13]. Although this critique relates primarily to the long term flexibility and adaptability of industrial buildings, a detailed consideration of which is outside the scope of this research, it is relevant also to change occurring during the building process.

The building process takes time. Although microeconomic theory makes no provision for this, changes to the firm's production requirements occurring during this process are presumably accommodated by making the smooth marginal adjustments to the building under construction which Fothergil *et al* argue are difficult to accommodate afterwards. However, the building process, involving the commitment of considerable intellectual, physical and financial resources, cannot easily accommodate these continuous adjustments, particularly as it progresses through time. How the firm, as corporate construction client, may make these adjustments is not at all clear. Indeed, it will be argued below that the construction industry discourages change to projects from an early stage precisely because the task of incorporating change is perceived to be problematic.

1.3 RESEARCH STRATEGY

1.3.1 Intention and aims

The rather wide ranging discussion presented thus far has introduced the main lines of enquiry which motivate the present study and the theoretical background to the problems to be investigated. It also suggests a potentially rewarding direction for the examination of these problems and for an exploration of related issues.

In that the orientation of theories of corporate finance and microeconomics is toward the costs and financial benefits of capital investment, they appear to say very little about how the firm's management actually make and implement capital investment decisions. An alternative approach is therefore required for an examination of the problems raised above. The construction procurement literature - with its lack of a client perspective - also appears to fall short of providing a useful framework for an examination of its corporate client's problems.

Although these conflicts are discussed in more detail in chapter 2 below, it may be noted that the intention in this study is to consider the problems raised as part of management's wider problem of resource allocation. Central to this study is the view that the problems, considered from this perspective, raise important organisational and human questions which a management approach will allow for a serious exploration of the issues involved. The study draws on recent work in the business administration area which has focused on the capital investment problem as a process of resource allocation through time involving the firm's management. This orientation provides valuable new insights into the resource allocation process which are particularly relevant to the present research.

The work by Bower (1970) in particular provides an analytical framework within which management action during the resource allocation process may be examined. By describing the process as occurring across many levels of the corporate hierarchy and over long periods of time, Bower's resource allocation model suggests a set of propositions for study which direct attention at key features of the process. The aim of this study is to examine these propositions to help explore how the firm's management manage the construction contribution to capital investment projects and how they ensure that the firm gets a suitable factory building. The model and the research propositions are discussed in more detail in chapter 3 below.

1.3.2 Approach

Given the focus and perspective taken and the problems to be examined, the study is based on a detailed and intensive examination of the process of capital resource allocation in respect of a factory building project in each of two large manufacturing firms. A more detailed discussion of the research strategy and methodology is provided in chapter 4 below, where particular emphasis is placed on the essentially exploratory nature of the research.

1.3.3 A note on uncertainty

Fundamentally, the problem of implementing industrial building investment decisions would be greatly simplified if the firm could be certain about the factory buildings it required well into the future. In this case, implementation would be largely as currently characterised within investment theory, ie constructing that project which has been defined in the investment decision.

However, because of the indivisible and long-lived nature of buildings, it may be expected that firms contemplating acquiring new buildings will normally take a long term view of their building requirements. Indeed, Fothergil *et al* (1987) argue further that as the acquisition of a new factory is typically part of a major strategic decision involving considerable managerial effort and disruption, such decisions tend to be taken infrequently and reluctantly. It would appear therefore that the willingness (as well as the ability) of the firm continually to adjust that part of its productive capacity represented by buildings may be limited.

Whether the manufacturing firm displays such a reluctance to undertake major capital investment projects is a question for research. The point here, however is that as the future is unknowable, the firm's prediction of future needs is inherently uncertain. Indeed, if uncertainty depends on time, then it may be expected that the further into the future the firm must look - the longer the new building is expected to last - the more uncertain will be the firm's estimate of its building requirements. In any event, the nature and scope of a factory building defined within an investment decision is uncertain; the extent of this uncertainty is of less interest here. And although an investigation of problems related to this uncertainty may seek to examine whether the firm may make more accurate predictions, this study is concerned with the problem of managing the building procurement process in conditions of uncertainty.

1.4 THE RESEARCH TERRITORY

This section outlines the research territory to be investigated: a more detailed discussion of the choice of firms for analysis is presented in chapter 4 below.

1.4.1 The large manufacturing firm

Although the present research may be said to be project-oriented, in that it deals with management action on individual projects, the unit of analysis is the large manufacturing firm. More specifically, it is those managers and personnel involved in a capital investment decision leading to the construction of a new factory building.

The large manufacturing firm has grown to a position of pre-eminence in industrial society in recent years. It has also attracted considerable attention from organisation researchers, particularly in the business administration area. As will be seen, studies of the internal decision processes of large firms provide much material for the present study. In particular, these studies argue that the management of large firms, because of their size and organisational complexity, merits special attention. This study will argue that capital resource allocation and building procurement create particular problems for the firm's management for similar reasons.

1.4.2 Investment and building procurement

The capital investment process provides a somewhat unique and temporary setting for the examination of management action. The boundaries of the process are described in chapter 4 below. It may be noted here that the primary interest is in management action concerned with a particular investment project, although the emphasis on the firm will enable relevant material from outside of the immediate project boundaries to be accommodated. Finally, a particular type of capital investment decision is covered here - that leading to the procurement of a new factory building for the firm's own use as a production facility.

1.5 OUTLINE OF THE THESIS

This thesis is presented in eight chapters. This first chapter provides an introduction to the problems to be investigated, the focus and perspective taken and the theoretical background. It outlines briefly the research strategy and the locus of the research including the primary unit of analysis.

Chapter 2 begins with an overview of the development and importance of large firms. It develops two main themes through the literature which have been identified in chapter 1. These concern corporate capital investment and new building procurement. Corporate capital investment is discussed in terms of its organisational and political aspects and particular attention is paid to the management of the process and to the treatment of investment project implementation. Models discussed include those by Bower (1970) and King (1975). Additionally, the literature on building procurement and management is reviewed with a particular view to exploring the perceptions and understanding of the corporate client embedded within it.

In chapter 3 an analytic framework by Bower (1970) is presented and discussed. Propositions for research are then derived from this framework.

Chapter 4 provides a discussion of the research strategy and a review of methodological issues. In particular, details of the case study approach are given together with a discussion of qualitative research techniques for data collection and analysis.

The detailed case studies together with a preliminary analysis of case material are presented in chapters 5 and 6. One chapter is devoted to each case study.

Chapter 7 considers the research propositions in the light of the case studies and preliminary analysis presented in chapters 5 and 6. It provides comparisons and contrasts between the cases and examines the usefulness of the propositions to help explain management action during capital investment decision making and implementation.

Chapter 8 concludes with a consideration of the implications of the research findings for the firm's management, for construction management and for further research.

1.6 FOOTNOTES

1 Author's estimates based on Central Statistics Office (1992), *The Blue Book*, 1992 Edition, Table 13.2.

2 Author's estimates based on Department of the Environment (1992) *Housing and Construction Statistics,* March Quarter 1992, Part 2, Table 2.3.

3 For example, capital allowances to encourage certain categories of industrial building investment assume that high capital costs inhibit investment.

4 See for example, Archibald (1971), pp9-10.

5 See for example, Bromiley (1986).

6 For a summary, see Marsh *et al* (1988).

7 A spur to this may be found, in particular, in Arrow (1951) where the tensions between individual and collective action in the context of business organisations are explored; and in Simon's (1945) widely cited exposition of human decision making in organisations.

8 Empirical studies of corporate capital investment have tended to concentrate on large firms. Marsh *et al*, for example, refer to the "classic dilemma of large decentralized organisations" and argue that, in large companies

> "..final authority for major investments is vested in top management. ...(but) most strategic development in such companies comes from the divisions, rather than being top down." (1988, p2)

See also Bettis (1983) who queries differences between finance and corporate strategy paradigms, particularly as to assumptions about the competitive nature of markets. Some of these apparent conflicts are examined further in chapter 2.

9 The predominantly normative orientation of the building management and procurement literature is discussed in chapter 2 below.

10 See, for example, Kelly and Male (1991) on client's value systems; Bresnen and Haslam (1991) on client project management practices.

11 The point is argued more fully in chapter 2 below.

12 Production buildings have also attracted the attention of theorists outside of orthodox economics. Bon, for example, wishes to focus a theory of building economics on buildings used for the production of goods to relate it closely to the theory of capital of the Austrian school. He therefore distinguishes between buildings used for production - capital goods - and buildings, such as dwellings, which are consumption goods used for the satisfaction of human needs (1989, pp 5-6 and 28-9).

13 For an extension of this argument, see Fothergil *et al* (1987), chapter 4 and pp 56-7.

CHAPTER 2: MAKING AND IMPLEMENTING CAPITAL INVESTMENT DECISIONS

2.1 INTRODUCTION AND OVERVIEW

This chapter examines the literature on the ways in which large firms make and implement capital investment decisions, concentrating in particular on two broad streams of study; the first in the business administration/corporate strategy area, and the second concerning building procurement and management. Although the discussion begins with an overview of the importance of large firms as agents in the economy and as subjects for study, the discussion is primarily at the level of the individual firm.

The argument is developed that within the large firm, capital investment is a 'bottom-up' process where proposals for major investment arise from the operating divisions to progress up the management hierarchy before being reviewed by top management. Such a process tends to receive little attention in theories of finance and microeconomics and, in particular, within the literature on building procurement and management, where investment decision making tends, by contrast, to be characterised as "a single act of top management deliberation"[1]. The discussion explores some of the implications for the implementation of building investment decisions of this apparent conflict of paradigms and concludes with key questions for research.

2.2 THE IMPORTANCE OF LARGE FIRMS

2.2.1 Importance as economic agents and subjects for study

The increase in industrial concentration and the development of the large business enterprise has been a feature of the economic histories of both the US and the UK - and, for that matter, most other economically advanced Western countries - in the latter half of the present century (see Hannah, 1983; Goold and Campbell, 1987). More recently, however, the growth in dominance of the large enterprise has slowed. Hannah (1983) argues that:

> "the 1970s and early 1980s proved, like the 1930s and 1940s, to be a period of lull in the advance of the corporate economy"[2].

Despite this, large firms continue to dominate most aspects of economic activity. Davies *et al* (1991) examined concentration in UK manufacturing industry in 1979 and 1986 to argue that the leading two or three firms dominated most markets and that market leadership was relatively stable over that period[3]. Furthermore, there have been sharp increases in merger activity by manufacturing firms since the mid 1980s - both in terms of number of firms and value of assets involved[4] - pointing to an advance in merger-led expansion of large corporations fuelled by a stock market boom predicted by Hannah in 1983[5].

2.2.2 Strategy, structure and problems for management

Ever since Berle and Means (1932) argued that a separation of ownership from control had occurred in the large modern corporation, considerable interest has been directed towards the workings and activities of large firms. Although much of this interest has concerned testing or extending Berle and Means's thesis (eg in the UK see Nyman and Silberston, 1978; Cubbin and Leech, 1983), the problems of organising and managing the large firm have also received much attention.

In particular, the relationship between the firm and its business environment has been the subject of enquiry for some time. For example, Galbraith (1967) argued that the large firm sought to control uncertainties in its environment through the 'technostructure', an apparatus for group decisions of non-owning managers who had replaced the traditional owner-entrepreneur[6]. This technostructure allowed the firm to grow by integrating its operations and extending its sales in an effort to stabilise its environment. A rather different perspective was taken by Chandler (1962) who examined corporate growth as a function of the firm's strategy of diversification.

Chandler's study is particularly relevant to the present research in its examination of the structural and organisational implications of growth by diversification. He examined growth in some 70 large US corporations and noted that growth strategies of diversification and geographical expansion led to administrative problems for top management. The problem of managing the disparate needs of different markets became more difficult with increasing size, especially where the strategy of product-market diversification was pursued.

The development of the multi-divisional structure at Du Pont and the General Motors Corporation in the USA in the 1920s (and in Imperial Chemical Industries Ltd - ICI - in Britain in the 1930s) was a direct response to these problems and enabled diversification strategies to be pursued. Such strategies and structures were rapidly adopted by the majority of the large American international companies and, somewhat later, by the majority of large British companies also (Channon, 1973[7]; Prais, 1976; Hannah, 1983). Much subsequent research into diversification has concentrated on comparisons between the performance of diversified and non-diversified companies, with generally mixed and inconclusive results[8].

The particular significance of the multi-divisional structure to the present study is the decentralisation of decision making. Divisional managers may have considerable autonomy over decisions affecting the future of their businesses. Corporate headquarters under the control of top management - that small group of executive board members at the top of the corporation - are more concerned with company-wide issues and restrict their activities to planning, appraisal and control. Barwise *et al* (1987) argue that effective product-market strategies come from the divisions, with their detailed understanding of the market and the company's competitive position, which top management do not share directly[9]. It is this discrepancy in the knowledge available to managers at different levels within the hierarchically structured large firm which is at the root of the problem now to be examined.

2.2.3 Large firms as subjects for study: theoretical origins

Concern with the workings of organisations in general and the management of business organisations in particular has led to the establishment of a significant area of investigation within social science. Nevertheless, although the problem of management of the large firm is now the subject of an extensive literature, relatively little attention has been devoted to the management of the resource allocation process in particular. What work has been done has drawn considerably on research into the more general workings and activities of organisations and, more particularly, on the relationship between the firm and its environment and on decision processes within firms. Before proceeding to a consideration of the specific problem of resource allocation, therefore, it is appropriate to consider briefly the wider theoretical context within which the problem of managing large firms has been examined.

Burrell and Morgan (1979) trace the historic development of organisation theory and locate this within the 'functionalist paradigm' of social science[10]. They identify a number of interrelated lines of enquiry in this development, all of which stem from two approaches at the forefront of human relations studies[11]. The first of these is the 'orthodox' school of management and administration theory, oriented towards management concepts, problems and prescriptions, characterised by the work of Taylor (1947) and Fayol (1949). The second is the work of the early industrial psychologists concerning the behaviour of people in organisations (see Lupton, 1971). Although both survive in contemporary work, recent advances have been made which are more directly relevant to this thesis, in particular those that focus on questions of the goal orientation of organisations, decision making process within organisations and on the relationship between an organisation and its environment.

Organisation goals and decisions

The significance of these developments to this thesis is that initially they challenged more conventional management and economic thinking, particularly related to the economic theory of the firm. Orthodox economic theory embodies the scientific or rational model of decision making which involves the choice of the optimum solution following the evaluation of all possibilities. Although considerable challenges to corporate maximising behaviour had arisen since the work of Berle and Means in 1932[12], the notion of 'administrative man' developed by Simon (1945) with an emphasis on the 'satisficing' rather than the maximising behaviour of 'economic man' of orthodox economics was particularly influential[13] and led to a number of alternative models of organisational decision making (see, for example, Allison, 1969; Butler *et al*, 1993). Four key models are reviewed briefly below.

March and Simon (1958) and Simon (1960) proposed a 'bounded-rational' model of decision making. March and Simon (1958) argued that the complexities of problems facing organisations are of such a magnitude that managers seek satisfactory rather than optimum performance, attend sequentially to objectives and deploy standard "repertories of action programs" to deal with recurring situations[14].

Cyert and March (1963) concentrated on corporate decisions and viewed the firm as a grouping of sub-coalitions of individuals which created the potential for conflict in the formation of organisational goals. In their political model of organisational decision making such conflicts are resolved by the sequential rather than the simultaneous attention to goals[15,16]. These developments showed early theoretical promise and attracted the attention of many orthodox - and influential - economists (for example, Williamson, 1964, 1971; Machlup 1967; Baumol and Stewart, 1971). Further, their associated methodologies also suggested new approaches to the examination of decision making and management action which influenced more mainstream organisation and management research (see, for example, Pettigrew, 1973; Hickson *et al*, 1986).

Other key developments include the 'garbage-can' model of organisational decision making (Cohen *et al*, 1972) - within which decisions are frequently made under problematic, uncertain and ambiguous conditions - and the contingency model of Thompson and Tuden (1956). This latter model considers problems of decision uncertainty and raises the question of the relationship between an organisation and its environment.

Organisation and environment

Concern with environmental influences led to an open systems view of the firm, typified by Katz and Kahn (1978) whose main concern is with the organisation as an energic process of input, throughput and output, rather than as a physical structure[17]. This model considers that organisations are essentially purposive in nature, and are analagous to biological organisms[18].

Empirical studies of the influence of environmental factors and technology on organisation (for example Burns and Stalker, 1961; Woodward, 1965)[19] have led to a contingency model of organisation refined by Lawrence and Lorsch (1967). The concepts of differentiation and integration introduced by Lawrence and Lorsch to help explain how the firms they studied adapted to the instability and uncertainty in their environment[20] are particularly important for an examination of the problem of managing the large divisionalised firm.

As will be seen, the ideas introduced above are important to a consideration of investment decision making within large firms. Of course the development of organisational research has not been restricted to these lines of enquiry (for an overview, see Morgan, 1986). Indeed, subsequent work within the contingency framework, for example, has been concerned with the design of organisations (Galbraith, 1973, 1977; Mintzberg, 1979); behavioural theories have been elaborated within an economic analysis (Cyert and Simon, 1983).

2.3 CORPORATE CAPITAL INVESTMENT DECISIONS

There are two main streams of literature concerning corporate capital investment. The first is located within the maximising paradigm of orthodox economic theory. The second concerns capital investment as a social process within large organisations. The latter has arisen largely out of attacks on the realism of the former, particularly from the behavioural approach to organisational decision making briefly introduced above. Conflicts between these paradigms have already been noted in chapter 1 above (section 1.2.2) and are reviewed below.

2.3.1 Purpose and process in corporate capital investment

Capital investment is such a fundamental activity to corporate survival and growth that it occupies a central position in a number of disciplines, most especially in microeconomic theory and in theories of corporate finance. These treatments of investment tend to focus on decision rules for the maximisation of profit - or another variable[21]. Much of the economics literature concerned with investment decisions is interested in the determinants of investment and the economic conditions under which successful investment is possible[22].

Within the closely related literature on corporate finance and capital budgeting, there is a strong emphasis on the identification and development of techniques for the evaluation and appraisal of investment options (Merrett and Sykes, 1973; Levy and Sarnat, 1986; Bierman and Smidt, 1988). The point here is that as much of this literature embodies the rational model of decision making, the characterisation of the investment problem within theories of economics and finance is thus as one of choice. And the prescriptions for choosing are mainly financial. The problem of how investment decisions are actually made receives little attention. As Pinches (1982) argues:

> "... the fact remains that there is a substantial gulf between what financial theory says about capital budgeting decisions and how firms actually make these decisions"[23].

2.3.2 Questions from corporate finance

Questions about the process of capital investment from within the corporate finance area were initially raised because of concern about the extent to which firms actually followed theoretical decision rules. A survey by Istvan (1961) found that such techniques were not widely used[24]. Williams and Scott (1965) found that formal evaluation techniques were used sparingly and supplemented by considerable managerial judgement in the 14 firms studied. They wondered whether investment was so complex that evaluation of every implication was not possible[25].

Cannon (1968) in an examination of 4 of the 14 firms studied by Williams and Scott found that managers believed in their ability to foresee the future accurately and relied on unchallenged assertions of product demand[26]. That managers appeared to behave irrationally raised questions about the complexity of investment decisions and the social and political context within which such decisions were taken (see Berry, 1984).

2.3.3 Contributions from the corporate strategy area

Bromiley (1986) identified two major trends in the strategic management literature relating to corporate capital investment. The first examines the process of investment by which individual projects are identified, developed, justified and approved and is typified by the work of Aharoni (1966) and Bower (1970). The second concerns planning and investment systems and, in particular, a contingency approach to corporate planning systems (Lorrange, 1972)[27]. As this thesis is more concerned with the former approach, that is with an examination of how capital investment decisions come to be made - and implemented - work in the latter area will be mentioned only briefly here.

Aharoni (1966) examined corporate decisions to invest in another country and described the decision as a process within an organisational context. This extended earlier work on investment decision making in large corporations (Berg, 1963; Sihler, 1964). Another key work in this tradition is that by Bower (1970) who examined investment decisions in each of four divisions of a large, diversified US company and significantly extended the work of Ackerman (1968), Aharoni, Berg and Sihler. Bower's model provides a useful framework within which to address the research problems of concern here and will be discussed in greater depth in chapter 3 below[28]. For now, however, it is important briefly to acknowledge Bower's distinctive contribution to the literature.

Bower's study highlights the importance of capital investment as a process of resource allocation spread over long periods of time and across many levels of the corporation. He argued that, unlike the prescriptive theories of finance and economics which emphasised the role of top management in choosing between investment options, the process as observed was more 'bottom-up'. Investment proposals arose from the divisions and were developed and attracted support as they progressed through the management hierarchy, arriving with top management as ready packaged projects which were either accepted (more likely) or rejected, but hardly ever changed.

It is notable that Bower examined capital investment projects which led to the acquisition of new production facilities. His analysis owes much to the picture of man within organisation developed by Simon (1945) and to the political model of organisational decision making outlined by Cyert and March (1963). An important element in Bower's model is the activity of integration which is necessary to reconcile the needs of divisional managers with those of top management and draws heavily on Lawrence and Lorsch (1967). These antecedents are considered more fully in chapter 3 below.

2.3.4 Research into investment decision making in large firms

Early support was provided for Bower's analysis by Ackerman (1970), who found that investment projects were not selected by top management on a corporate-wide consideration of the project's worth[29]. Carter (1971) examined six corporate planning decisions in a large corporation within the Cyert and March behavioural framework and found that decisions were made on the basis of 'threshold levels' related to managerial competence. These threshold levels were consistent with the bounded rationality approach of Simon. Carter argued further that management may consider more aspects of proposals involving strategic decisions than in the case of operating decisions (the focus of Cyert and March's behavioural theory)[30].

To cite yet another instance, Mintzberg *et al* (1976) examined 25 corporate strategic decision processes in terms of three broad phases of identification, development and selection. They note that a critical problem in capital investment decision making in large firms is related to discrepancies in knowledge available to managers at different levels in the firm (see 2.2.2 above):

> "...authorizers generally lack the in-depth knowledge that the developers of the solution have. In capital budgeting... choices are made by people who do not comprehend the proposals presented to them. Thus, in authorization, the comparative ignorance of the manager is coupled with the inherent bias of the sponsor. This explains why empirical studies of capital budgeting have shown it to be a somewhat distorted, political process far less analytical than the normative literature suggests"[31].

In the UK, King (1975, 1975a) examined three investment decisions in two large companies. He uses the concept of 'disjointed incrementalism' (Braybrooke and Lindblom, 1963)[32] to criticise weaknesses in the 'scientific model' of decision making applied to actual decisions, and questions normative capital budgeting theory as providing useful descriptions of the investment decision process as observed. King's model divides the process into six stages: triggering, screening, definition evaluation, transmission and decision. He attributed the finding that not all possible alternatives are evaluated as due to the limited problem solving capacity of organisations and individuals. His 'transmission' stage is directly comparable to Bower's emphasis on the 'impetus' given to projects as they attract support and sponsorship at successively higher levels in the corporate hierarchy:

> "In a hierarchical organisation the case for investment has to be transmitted upwards through the organisation. This will be an essentially political process during which the proponents of the project seek higher level sponsors."[33]

Further work in the UK includes that by Berry (1976, 1984) who studied a large functionally divisionalised single product firm (electricity generation and supply) in the UK public sector. His approach through the open socio-technical systems paradigm (in the tradition of Katz and Kahn, 1978; see 2.3.1 above)[34] considered the capital budgeting process as "an integrative procedure for top management" in that it linked the economic and financial conceptions of top management with the technical and product-market conceptions of lower level managers[35]. Although this resembles the role of integration in Bower's model, Berry argues that the open systems approach has allowed management behaviour to be observed without having to treat this behaviour as resulting directly from top management objectives which, he argues, is necessary in Bower's analysis. This critique is returned to in chapter 3 below.

More recently, Marsh *et al* (1988) have examined major investment decisions in each of three large UK companies. Their approach, in the tradition of Bower (1970) and King (1975) was to track decisions from their origins within the organisation to final approval by top management. They found much to support the view of investment as a 'bottom-up' process involving processes of definition, transmission through the organisation and approval in line with Bower (1970), Ackerman (1970), King (1975), Mintzberg *et al* (1976) and Hickson *et al* (1986). In addition, they suggest that top management may manipulate the organisational structure in an attempt to influence the behaviour of lower level managers in desired directions (Bower, 1970), but consider that top management have a more direct role in the investment process than acknowledged either by Bower or King[36].

The discussion now turns to a consideration of the key issues arising from empirical studies of the process of capital investment decision making.

2.3.5 Summary of key issues

Firstly, most of these studies highlight the importance of capital investment as a process, often occurring over quite lengthy periods of time and involving different levels within the corporation (Williams and Scott, 1965; Berg, 1963; Sihler, 1964; Aharoni, 1966; Ackerman, 1968, 1970; Bower, 1970; Carter, 1971; King, 1975, 1975a; Mintzberg, *et al*, 1976, Berry, 1976, 1984; Bromiley, 1986; Marsh *et al*, 1988). Bower (1970), King (1975) and Pinches (1982) in particular argue that the traditional emphasis in capital finance theory on the role of top management in the final 'decision' stage is misplaced.

Secondly, capital investment decisions in large corporations are observed as a 'bottom-up' process, where proposals which arise from within the divisions are transmitted up the management hierarchy before approval by top management. Although the extent to which top management participate in this process was observed to vary, generally top management's role is, as Chandler (1962) observed, more concerned with planning and control than with operational matters[37]. An additional and important point is that this bottom up process is characterised by the political nature of sponsorship/transmission. Sponsorship involves the commitment of managers who must believe in the value to them of supporting the investment proposal; managers lower down the hierarchy must secure the support of those higher up if their proposal is to stand a chance of success (Berg, 1963; Aharoni, 1964; Ackerman, 1968, 1970; Bower, 1970; Carter, 1971; King 1975; Hickson *et al*, 1986; Marsh *et al*, 1988).

Thirdly, the process takes place within an organisational structure and within a wider environment. The formal organisational structure, ie the systems of information transmission, control, performance measurement and reward can influence the investment process, particularly the kind of projects that are identified for proposal to top management (Carter, 1971; King 1975). Although a theory relating particular behaviour to precise organisational forms has long been a goal for research[38], Bower (1970) in particular argues that organisational structure or context can be manipulated by top management to influence the behaviour of lower level managers who are involved more directly in the resource allocation process. This is given some, though by no means conclusive support by Marsh *et al* (1988), who argue that tracking a single investment in each of three companies gives limited data for investigating the influence of structure, and that structure is designed on a wider set of considerations than encountered on any narrow consideration of investment decision making[39].

Finally, descriptive models of the corporate investment process have been outlined which, while different in detail, confirm the process as comprising a number of phases or sub-processes covering project identification, transmission across the hierarchy and approval (Aharoni, 1966; Bower, 1970; Ackerman, 1970; King, 1975; Mintzberg *et al*, 1976).

2.3.6 The importance of process and the role of implementation

The studies reviewed above portray a radically different picture of capital investment from that contained within the corporate finance and economics literature. However, the thrust of the argument developed below is not against the descriptive accuracy of normative finance and economics theory, for such theory does not claim to describe the actual decision processes of individual firms[40]. The argument seeks instead to emphasise and describe corporate capital investment as a process of decision making - rather than a single decision - leading to the acquisition of new factory buildings. Whether investment outcomes approximate to the maximising behaviour of orthodox economics is of little concern here.

Indeed, the empirical studies of the capital investment process reported above may be criticised for their lack of emphasis on the financial and economic aspects of investment. Few studies have focused on both process and financial or economic analysis. Recent work has attempted to redress this shortcoming, most notably by Bromiley (1986) who examines corporate planning behaviour and uses the resulting empirical observations to generate quantitative econometric models[41] in the tradition of Baumol and Stewart (1971). In that Bromiley's concern is with the economic determinants of investment and his focus is on aggregate investment planning in line with the work of Lorrange (1972, 1979) rather than on individual projects in the tradition of Bower (1970), King (1975) and Marsh *et al* (1988), his work is less directly relevant to this thesis. However, Bromiley found a number of similarities between the four firms he examined and the firm examined by Bower and he also observed that investment decision making was a 'bottom-up' process[42].

The empirical studies and analyses which view corporate capital investment as a process of bargaining and choice, spread across many levels of the firm and over long periods of time,[43] are relatively few in number. However, they raise important questions of how the corporate client of the construction industry obtains a suitable new building. In order to bring these questions, and, specifically, their implications for construction into sharper focus for research, the discussion now turns to how corporate clients are portrayed within the construction procurement and management literature. Prior to this, however, it is important to consider the treatment of project implementation in the literature reviewed up to now.

In almost all of the studies examined here, the capital investment process was considered to be concluded with the authorisation of investment funding by top management. In the few cases where implementation was considered, the financial outcome of the project was the main focus (Williams and Scott, 1965; Cannon, 1968). The key work reviewed above adopted a longitudinal, case-based approach which tracked decisions only up to top management approval (Bower, 1970; King, 1975; Marsh *et al*, 1988), with little interest in either the process or outcome of project implementation. Indeed, in some cases the work was written up before the investment projects examined had been implemented (Marsh *et al*, 1988).

Bower (1970) considers implementation in terms of the practicality of effecting strategic choices, ie the choice of organisation structure to enable strategic objectives to be achieved[44]. There is no consideration of the implementation of individual investment projects as involving the procurement of building work spread over time. For a consideration of the client's role in implementing capital investment projects therefore, attention must now be directed to the literature on building procurement and management.

2.4 IMPLEMENTATION AS A CONSTRUCTION PROCESS

2.4.1 Introduction and recent developments

The literature on construction procurement and management is now extensive. In recent years a considerable amount of research attention has been devoted to the study of project management, in line with the rise to prominence of project management as a distinct professional discipline within the UK construction industry (Bennett, 1991; Royal Institution of Chartered Surveyors, 1991; Smith and Morris, 1992). The proliferation of building procurement methods since the early 1980s in particular has provided considerable scope for enquiry (Harris and McCaffer, 1989).

Additionally, there has been renewed interest in the operation and management of the construction firm (Hillebrandt and Cannon, 1989, 1990; Newcombe *et al*, 1990, 1990a). Recent developments in strategic management (eg Porter, 1980, 1985, 1990) have helped continue the interest in the construction firm from a corporate strategy perspective (Langford and Male, 1991; Male and Stocks, 1991; Betts and Ofori, 1992). Despite this plethora of research activity, there has been relatively little interest in the role of building clients in general and corporate clients in particular.

2.4.2 The focus of construction research and the client role

The process of building design and construction within functional, temporal, monetary, institutional, statutory and aesthetic constraints and considerations is a complex one (Stone 1983). If the concerns of construction research have focused primarily on construction problems, it may be argued that the idiosyncratic nature of the building process has provided more than sufficient scope for enquiry. In spite of this, the building process remains susceptible to problems of delay, cost escalation and product quality[45].

While it is not the intention to catalogue these problems here, a brief review is instructive for an examination of the client's role. Concern in the early 1960s with construction industry practice and performance (Emmerson, 1962; Banwell, 1964) prompted a range of studies - particularly at the Tavistock Institute - which initially associated problems with interrelationships and communication between the participants in the construction process, including the client (Higgin and Jessop, 1965; Crichton, 1966, Bryant *et al*, 1969). These studies explicitly recognised that construction clients were frequently large organisational 'systems' which had to be considered separately from the construction process. Higgin *et al* (1965) argued that clients were often "complex systems of competing interests" which the building industry needed to take into account:

> "We have the impression that in its relationships with its client systems, the building industry not only does not take sufficient account of the complexity of the organisations it is dealing with, but tends to be impatient of this complexity."[46]

Despite this early recognition of the client as an organisation and the interest in the client's role on construction projects, much work since has paid little attention to these ideas. This point is returned to in more detail in section 2.4.3 below.

Throughout the 1970s and early 1980s a series of reports by the National Economic Development Office focused on more specific problems in the industrial and engineering sectors of construction (National Economic Development Office, 1970, 1976, 1976a, 1978, 1983). This focus upon the industrial building sector is particularly important to the present study and arose partly from the UK Government's industrial strategy and concern about the implications for construction of an expected policy shift toward the regeneration of manufacturing industry[47]. It also arose from unfavourable comparisons between the performance of UK and foreign construction industries (Wilson, 1969; and especially Slough Estates, 1976, 1979), particularly as regards construction times[48]. National Economic Development Office (1983) reports in considerable detail a questionnaire survey and 56 case studies of factory building projects (35 of which were purpose built for clients' own uses). Although the client role is examined, there is little detail provided on the internal process of decision making within the client organisation. The focus is restricted to client attitudes towards - and aspects of the project affecting - the duration of the construction process[49].

During the 1980s the focus of enquiry within construction related research shifted more towards different forms of procurement and management. This arose partly from increasing criticism of, and decline in 'traditional' procurement practices (Chartered Institute of Building, 1988), and partly from changes in the strategic positioning of construction firms keen to offer differentiated management services (Hillebrandt and Cannon, 1990[50]).

Indeed, client criticism has at times been forthright and directed at the overall performance of construction in general with particular emphasis on management to time and cost criteria (Royal Institution of Chartered Surveyors, 1982; British Property Federation, 1983). However, much of this criticism has tended to argue from the point of view of those developer-clients whose interest is in buildings as income generating goods rather than production goods[51] (Slough Estates, 1976, 1979; British Property Federation, 1983). While the developer-client perspective addresses important concerns, it tends to miss aspects of the corporate capital investment process that are particularly important for the present study.

First, developers are likely to be smaller organisations than the large manufacturing firms of concern to this study[52]. Secondly, unlike manufacturing firms building new factories for their own use, speculative developers are not concerned with the building as a factor of production in their own business. Thirdly, developers who do not build for their own use will not normally need to reconcile the accommodation needs of potentially conflicting internal departments. Fourthly, the business of property development includes the regular procurement of building work. It has already been noted that manufacturing firms tend to invest reluctantly and infrequently in new buildings (section 1.3.3). What may be a routine decision for a developer may be a major one for a manufacturer. Finally, developers generally provide relatively small standardised factories to suit a notional client's accommodation requirements (Centre for Advanced Land Use Studies, 1979, 1984). Fothergil *et al* (1987) argue that the emphasis given to the development-for-sale scenario in the literature on industrial property and buildings has tended to bias this literature towards consideration of the needs of small firms[53].

2.4.3 The corporate client within the construction literature

The argument being developed is that despite considerable research activity - some of which has been motivated by client criticism - the characterisation of the client within the construction procurement and management literature has not altered radically from the perception of a unitary and decisive entity which the Tavistock Studies in part sought to dispel (Higgin and Jessop, 1965; Higgin *et al*, 1965). Further, this literature tends to ignore the important corporate investment process by which decisions about building needs are made.

The two problems raised in chapter 1 (section 1.1.2) provide a focus for the examination of how the corporate client is portrayed within the construction procurement and management literature. The first of these problems concerns how the firm may manage the involvement of the construction industry in the firm's capital investment decisions. The second concerns the firm's role during the process of construction to ensure that the building finally obtained is suitable. To examine what the literature has to say about these problems, the role of the client in briefing, procurement and construction management will each be reviewed.

Briefing and the client

The models and descriptions of capital investment decision making discussed in section 2.3.4 above include a process or phase of 'project definition'. This includes the briefing process[54] whereby the firm's building requirements are identified and translated into design proposals, at least to the extent which would allow the feasibility of the resulting scheme to be established. Construction designers in particular have considered this briefing to be of great importance to subsequent design development and construction work (Newman *et al*, 1981); many problems associated with the building process are frequently thought to originate in inadequate briefing (Mackinder and Marvin, 1982). Indeed, so important is briefing perceived to be that there is much guidance currently available on the conduct of adequate briefing (Ministry of Public Buildings and Works, 1965; National Joint Consultative Council, 1973; National Economic Development Office, 1974, 1985; Chartered Institute of Building, 1980; O'Reilly, 1987; Building Services Research and Information Association, 1990). Similarly, a good deal of the construction procurement and management literature stresses the importance of briefing (eg Ashworth, 1986; Walker, 1989).

However, such guidance tends to be written from a construction industry perspective and considers the problem as one of building design (Newman *et al*, 1981; Salisbury, 1990; Kelly *et al*, 1992)[55]. Further, it often pays little attention to the process by which investment decisions are made - and within which projects, and building needs, get defined. Indeed, the client within the briefing literature is largely unitary, decisive, clear and capable - with professional help - of articulating building requirements to the construction industry (Goodacre *et al*, 1982). Briefing guidance which recognises corporate or organisational clients tends to require that these clients be represented by an authoritative and decisive individual (National Joint Consultative Council, 1973; Chartered Institute of Building, 1980; National Economic Development Office, 1985; O'Reilly, 1987; Building Services Research and Information Association, 1990) or an equally authoritative 'decision making unit' (Kelly *et al*, 1992).

Although such prescriptions are intended primarily to help the building design and subsequent construction activities, they may also help clients. By emphasising the need for a clear and unambiguous statement of building needs they require clients to think hard about their requirements (Goodacre *et al*, 1982). Seen from another perspective, however, some of the construction industry's 'impatience' with client organisational complexity argued by Higgin *et al* (1965) and Cherns and Bryant (1984) is discernible. Little consideration is given in the briefing literature to the extent to which the client organisation may be capable of being represented by a single decisive voice.

More importantly for the present study the capital investment context within which clients' decisions on building requirements are made is largely left out of the construction briefing literature. In particular, there is little or no recognition of the process of investment decision making spread across levels of the corporate client's organisational hierarchy and over long periods of time charted by, for example, Bower (1970), King (1975), Marsh *et al* (1988). Further, in its emphasis on a single authoritative voice, the briefing literature ignores the essentially 'bottom-up' nature of the corporate capital investment process, where proposals and detailed requirements come from within the divisions of large organisations rather than from top management.

In summary, the role of the corporate client within the briefing literature is as a largely unitary and decisive entity from which information on building needs is elicited by building designers. Finally, briefing is seen as a building design problem; there is no consideration of how the corporate client may manage and use the contribution of the construction industry at an early stage in preparing and progressing investment proposals. This point is returned to in section 2.5 below.

Procurement and the client

Much attention has been directed at the match between client type and needs, project type and procurement method[56]. As yet no theory of construction procurement has emerged to enable the choice of method to be related to the client's characteristics or building needs. Rather, such choice is seen as an 'expert' decision (Langford *et al*, 1987; Brandon *et al*, 1988; Kelly *et al*, 1992) involving a considerable degree of subjective professional judgement and discretion. Indeed, the debate on choice of procurement method has elements of a factional struggle between proponents of different systems with little sign of resolution (Centre for Strategic Studies in Construction, 1991).

The concern here, however, is with the treatment of the corporate client within the procurement literature and, more particularly, with how the client ensures that a suitable building is eventually obtained. A number of procurement guides focus specifically on new industrial buildings (Chartered Institute of Building, 1980; Royal Institution of Chartered Surveyors, 1981; Department of the Environment and Department of Industry, 1982; National Economic Development Office, 1983). Within these, clients are generally considered in terms of their need for speed of construction, for certainty of time and cost, for flexibility to change during the construction process and for technological complexity. The emphasis within this literature - and in the more general procurement literature (Harris and MacCaffer, 1989; Franks, 1990) - is on matching contractual arrangements to these criteria. The extent to which the client's organisational characteristics and decision processes influence the choice of procurement method is not generally considered. Nahapiet and Nahapiet (1985, 1985a) support the contingency approach outlined above. Although they argue that contract selection depends on client attributes, they are more concerned with the level of construction expertise available in-house (see also Stocks and Male, 1983; Bryman *et al*, 1988) rather than the client's organisational characteristics or decision processes *per se*[57].

The extent to which clients expect their requirements to change during the construction process would appear to have a more powerful effect on the choice of procurement method (Ireland, 1985; National Economic Development Office, 1985). In general, management or negotiated-type approaches tend to be favoured where the expectation of change during the construction process is high (for example, Department of the Environment and Department of Industry, 1982; Nahapiet and Nahapiet, 1985; Skitmore and Marsden, 1988).

This is supported in guidance available from the public sector client's perspective (HM Treasury, 1992a). Within this literature, however, the problem for the client is not how to organise the construction process toobtain the building required. Rather, it is portrayed as a problem of choice - with expert advice - from a menu of more or less standard approaches. Further, there is concern that the need for flexibility during construction will lead to cost and time penalties and is therefore widely discouraged (Chartered Institute of Building, 1980; Department of the Environment and Department of Industry, 1982; National Economic Development Office 1983, 1985).

Construction management and the client

The available literature on construction management[58] is extensive and it is not the intention to provide a detailed review in this thesis. Rather, the focus is on construction as a process of implementing a corporate capital investment decision. Particular attention will be paid to the role of the corporate client in obtaining a suitable building in conditions of uncertainty.

Cherns and Bryant (1984) provide a reminder that in almost two decades since the Tavistock Studies, relatively little attention has been paid in the construction literature to the client as a complex organisation. They raise 20 propositions for research concerning the client's role in construction management. These include the importance of the complexity of the client's organisation to how the construction process is managed, and the industry's impatience with this complexity. They argue further that only a close, in-depth study of the client's organisation can begin to address these issues[59].

A good deal of research into construction management generally has focused on the form of project organisation, what Cherns and Bryant term the 'temporary multiorganization'(TMO)[60]. As with the choice of procurement method, there is much debate as to the appropriate form of project organisation structure and, while there is general agreement on a contingency approach (Morris and Hough, 1987; Walker, 1989), there is less agreement on the particular choice of project form.

Morris (1973, 1982) argues that appropriate project organisation forms are dependent to a large extent on project characteristics of scale, complexity and urgency in particular; Morris and Hough (1987) add that the organisations sponsoring and building a project are also important[61]. Walker (1989) considers the extent of client expertise in project management or construction to be an important determinant of project organisation[62].

The role of the client has been receiving increasing attention in recent years (Department of Construction Management, 1989). Laufer (1990) for example, considers the process of capital project planning from the client viewpoint, arguing that the client's role in planning depends, *inter alia,* on the type of industry. This work was extended in Laufer (1992) where additional variables were identified as affecting client involvement in project planning, including the type of facility under construction and type of contract. Male and Kelly (1989) and Kelly and Male (1991) focus on an assessment of clients' 'needs' using structured functional analysis procedures within a value management framework. Bresnen and Haslam (1991) in a survey of 138 clients suggest that clients' choices of project management approach may be as much influenced by internal factors and familiarity than project-specific demands (see also Bryman *et al,* 1988). Despite this, however, the dominant theme in the literature concerns the overall management and leadership of project organisations. And much of the mainstream project management literature places this in the hands of professional project managers. Within the resulting frameworks - either functional, project or matrix[63] - the client's role is one of providing information and approving decisions. In this, clients have much in common with their counterparts in the briefing and procurement literatures: they are required to act as unitary entities, to be authoritative, decisive and certain of their requirements (O'Neill, 1989).

Some of the guidance on the management of construction projects emanating from client bodies reaches similar conclusions, particularly where the concern is with management to time and cost criteria. Recent developments within the UK public sector, for example, have focused on the control of public expenditure on capital projects. Following the 'Ibbs Report' of 1985 (HM Treasury, 1985), subsequent work (HM Treasury, 1986) recommended that government departments as project 'owners' and construction clients be represented by a senior and authoritative 'project sponsor' who would procure separate project management services. This separation of the role of client and manager is further underlined by a series of client guidance notes from HM Treasury's Central Unit on Purchasing (for example, HM Treasury, 1989, 1992, 1992a). The framework recommended places the project sponsor in a similar role to that of the client representative in much of the mainstream project management literature.

Another document claiming to argue from the client's perspective is the European Construction Institute (1991) which provides similar guidance on the authority, decisiveness and certainty required of the client role to that found in the mainstream briefing and project management literature.

While all of this guidance emphasises the need for management to cost and time criteria in particular, the public sector material must also be seen in the light of the UK Government's reappraisal of the role of government on public capital projects from that of provider to that of sponsor[64]. And although generally prescriptive, all of this material builds to a considerable body of argument about the management of construction projects and the client role.

It is not the intention here to be dismissive of this guidance. Rather, given the evidence available from empirical studies of the capital investment process within large organisations, questions may be asked about the emphasis on the unitary decisive client. In particular, the ways in which the client may implement a capital investment decision in circumstances where building needs may change in the short term is not at all clear. Although Gardiner and Simmons (1992) suggest that in terms of project organisations, problems which arise from project change are indicative of a systemic failure (ie it is not the change which is the problem, but the failure of the system to accommodate it), much of the guidance reviewed above counsels against major change during the process of construction (Walker, 1989; European Construction Institute, 1991; HM Treasury, 1992). More than that, structures and procedures which concentrate on time and cost criteria say little about how changed client circumstances are accommodated.

Walker (1989) attempts to address these problems. He devotes considerable attention to the client and the need to integrate the client's organisation with the project organisation. Indeed, his treatment of clients has been revised and updated since Walker (1984) to take account of Allen (1984), Cherns and Bryant (1984) and the Slough Estates' (1976) criticisms of UK construction performance in particular. Although the corporate organisation is viewed as an open-adaptive system in the tradition of Katz and Kahn (1978) with potentially conflicting internal objectives, there is an emphasis on the top management level as having authority for construction decisions[65]. Additionally, many of the prescripitive elements of the briefing literature outlined above - which emphasise the single authoritative voice - are re-echoed in Walker's prescriptions for the client representative role during the construction process[66].

A mechanism by which clients can incorporate changed requirements is outlined by Walker and involves the identification of key decision points by clients who expect their requirements to change. Opportunities for review are therefore provided; changes are made if feedback from the project or the environment indicates that these are required[67]. Whether project organisations contain such a mechanism is a question for research; indeed, Walker argues that the brief could provide the basis for this, but wonders whether normal briefs are adequate. The question of unanticipated change arising outside of the decision point/feedback mechanism is not considered but perhaps needs to be. Questions for research will now be addressed following a short summary of key issues arising from the review of the corporate client's role on construction projects presented thus far.

2.4.4 Summary of key issues

Problems with the construction process, together with attempts by construction contractors and consultants to offer differentiated construction and management services have motivated a largely prescriptive line of enquiry in the construction procurement and management literature. Further, the solutions offered tend to be concerned with choice of procurement or management method, where the focus on management to time and cost (and, latterly, 'quality'[68]) criteria predominates. Within this literature the corporate client *per se* receives no special attention.

First, a good deal of the literature on briefing, construction procurement and management consider the client as a unitary entity. Secondly, while much of the literature acknowledges the existence of client organisations (for example, Department of the Environment and Department of Industry, 1982; National Economic Development Office, 1983, 1985; O'Reilly, 1987; Walker, 1989), there is an emphasis that such organisations be represented by a single, decisive, authoritative voice. The dominant picture of the corporate client which emerges from the construction literature is of the single-minded sole entrepreneur of traditional economic theory[69].

Thirdly, the client representative is considered capable of speaking on behalf of the client organisation and of identifying clearly the organisation's building requirements. Fourthly, there is considerable emphasis within the literature that such requirements be stated with as much certainty as is possible early in the construction process. Change to projects during the process of construction is generally discouraged (for example, National Economic Development Office, 1985; Walker, 1989; European Construction Institute, 1991; HM Treasury, 1992).

Finally, while the construction literature has attempted to take account of the corporate client as an organisation, it pays little attention to the origins of the building project as arising from a capital investment decision. Similarly, the process by which investment decisions -

including decisions about building needs - are made receives little attention. The extent to which the construction industry may become involved in or contribute to these decisions is largely ignored.

2.5 CONCLUSION AND QUESTIONS FOR RESEARCH

The foregoing review has elaborated the conflict of paradigms relating to corporate capital investment outlined in chapter 1. Investigations into the way in which large firms make capital investment decisions have posed a direct challenge to the portrayal of the investment process in prescriptive theories of economic choice. However, such a challenge has not yet found its way into the construction literature. In particular, the characterisation of the corporate client in much of the construction procurement and management literature is as a unitary and decisive entity. The corporate client's decision process thus implied is at odds with empirical studies of the process by which large firms make decisions to invest in new buildings.

2.5.1 Construction involvement in investment decisions

While the discussion has helped clarify the problems for the firm's management raised in chapter 1, they remain unresolved. The first of these, concerning construction's participation in the investment decision prior to project approval, is not addressed in the literature on corporate capital investment decision making. The review of this literature, however, raises further questions about how the firm may manage construction's involvement in the decision process. For if investment within the large firm is characterised by a largely political process of 'impetus' (Bower, 1970) or 'transmission' (King, 1975) whereby projects are moved towards funding, the question then arises as to construction's role in this. Put another way, how can investment project promoters and sponsors use the plans, programmes, estimates etc provided by the construction industry to influence the outcome of the capital investment decision process?

The literature on construction briefing and procurement, with its emphasis on the unitary decisive client and on procurement choices available, also lacks a focus on the large corporate client to enable this question to be addressed as a problem for the firm's management.

2.5.2 Construction as an Investment process

The second problem raised in chapter 1 concerns how the firm's management, as construction client, can ensure that a suitable building is obtained. Within the literature on capital investment decision making, implementation is a largely instantaneous activity. This - presumably - involves procuring a building of the scope and within the expenditure limit defined in the investment project proposals which have been approved by top management. What happens if this definition needs to change during the implementation process is a wide open question.

The construction procurement and management literature accepts that client's needs may change and indeed offers ways to accommodate this (see for example, Walker, 1989). Firstly, however, procurement and management procedures as have been developed lay great stress on management to time and cost criteria, and generally discourage change - especially major change - during the construction process. Secondly, and more importantly for the present study, construction tends to be viewed as the end result of a decision to invest. Consequently, implementation is a largely technical, construction management problem; the client's role is as provider of information and as authoriser of decisions.

Seen from the corporate client's perspective and, in particular in the context of changing the nature or scope of the building being procured during the construction process, a rather different picture emerges. Indeed, the process by which the firm's management may identify changes in requirements, measure these against the building being procured, seek support and authorisation for any additional capital expenditure and ensure that necessary changes are made, may all be viewed in terms of a process of capital investment as described by, for example, Bower (1970), King (1975) and Marsh *et al* (1988). Seen in this way, implementation is more a continuation of the process of capital investment rather than an end result of it.

2.5.3 Research questions

This argument is of central importance and is developed further in chapter 3 below. It will be argued there and in chapter 4 that both problems may be addressed by examining management action during the process of making and implementing capital investment decisions in the large manufacturing firm. Consideration of the research problems thus far suggests that the field investigation needs to consider the following questions:

1. How does the large manufacturing firm make decisions to invest in a new industrial building for its own use as a production facility?
2. What is the role of the construction industry in this process? In particular, how does the firm manage construction's contribution?
3. What is the firm's role in the implementation of that part of the investment decision involving the procurement of a new industrial building?
4. How does the firm ensure that it gets the new industrial building it needs? In particular, how is change to project definition incorporated during the implementation process?

The model of resource allocation by Bower (1970) provides an appropriate and useful framework for an examination of how the firm's management deal with the problems raised as part of the resource allocation process. This model will now be examined in detail.

2.6 FOOTNOTES

1 Marsh *et al* (1988), p3.

2 Hannah (1983), p152.

3 Davies *et al* (1991) examined data for the top 5 market leaders in some 95 per cent of UK manufacturing industry between 1979 and 1986. On average only 1 of the top 5 did not survive in the top 5 over the period and the distribution of rankings and sales among the survivors did not change considerably (p3).

4 The number of UK industrial and commercial acquisitions more than doubled between 1985 and 1989, and the total value increased more than three-fold over the period; Central Statistics Office, Business Monitor MQ7 2nd Quarter 1990, Table 1, p2.

5 Hannah (1983), p156.

6 'The corporation', in Galbraith (1967), pp72-85.

7 Channon found that by 1970 some 60 per cent of the largest 100 British manufacturing firms were relatively highly diversified, and some 70 per cent had a multi-divisional structure, compared to 24 per cent and 8 per cent respectively in 1950; (1973, chapter 3).

8 For a general summary, see Goold and Campbell (1987), p16. For a more detailed review, including a survey of British manufacturing industry, see Grant, Jamine and Toker (1986) and Grant, Jamine and Thomas (1986).

9 Barwise *et al* (1987), pp1-2.

10 Burrell and Morgan (1979), pp21-35; four paradigms of social science are identified: functionalist, interpretive, radical humanist and radical structuralist. Work in the functionalist paradigm approaches sociological problems from a positivist perspective which attempts to apply the models and methods of the natural sciences to studies of human affairs.

11 Burrell and Morgan (1979), chapter 5.

12 For a summary, see Machlup (1967), Loasby (1971).

13 Simon sought to reconcile the rational aspects of human choice of interest to economists with the decision making behaviour of interest to psychologists and as observed. The concept of 'bounded rationality' - where decision making was 'rational' but bounded by limits on knowledge - was particularly important here (1976, 3rd ed, pp38-41).

14 March and Simon (1958), p169.

15 Cyert and March (1963), pp35-6, 117-8.

16 Cyert and March are also concerned with the relationship between the firm and its environment. They pay particular attention to the extent to which firms develop and adopt standard operating procedures in an attempt to control their environment and make it highly predictable (1963, pp118-120).

17 Katz and Kahn (1978), pp23-4. Burrell and Morgan argue that the theoretical conceptions of open systems theory with its emphasis on the largely intangible elements of structure have been difficult to examine empirically; such work tends to fall back on the more static and definable structural parts (1979, p160).

18 See Morgan (1986), chapter 3. Morgan considers 7 other 'metaphors' for the reading and analysis of organisations: machines, brains, cultures, political systems, psychic prisons, instruments of flux and transformation and instruments of domination.

19 Burns and Stalker examined how organisation and management changed with changes in technology and environment in a study of 20 firms (1961). Woodward found a relationship between technology and structure in a study of 100 firms (1965).

20 Lawrence and Lorsch argue that as systems grow they become differentiated (ie divided into parts each of which deal with specific aspects of the environment). The system as a whole requires to be integrated if it is to function and adapt to the circumstances in the environment. They conclude that business success is contingent upon achieving degrees of differentiation and integration compatible with the demands of the environment (1967), pp6-13.

21 In the long history of the theory of the firm, a variety of maximands - including profit - have been proposed; eg managerial utility (Williamson, 1964, 1971), sales (Baumol, 1967), growth (Marris, 1964, 1971).

22 For an overview, see Bromiley (1986),pp6-7.

23 Pinches (1982), p15.

24 A series of surveys during the 1970s and early 1980s appear to attest to the increasing acceptance of formal evaluation techniques (eg Klammer, 1972; Schall, *et al*, 1978; Scapens and Sale, 1981). More recently, however, Pike found that the more sophisticated techniques of risk analysis and management science tended to be used only in the larger firms (1983, pp206-7); McIntyre and Coulthurst found that medium sized UK companies relied heavily on simple evaluation techniques of payback (1985, pp53-4).

25 Williams and Scott (1965), pp95-7.

26 Cannon (1968), p193.

27 Bromiley (1986), pp8-9.

28 For an overview of the model, see chapter 3, section 3.2.1.

29 Ackerman (1970), p351.

30 Carter (1971), p426.

31 Mintzberg, *et al* (1976), p260.

32 Braybrooke and Lindblom (1963) argue that decisions tend to be incremental; decision makers tend to make small incremental changes in response to immediate pressures rather than formulating clear policy goals, p113.

33 King (1975), p77.

34 For a discussion of the open socio-technical systems paradigm, see Burrell and Morgan (1979), pp154-9.

35 Berry (1984), pp78-9.

36 Marsh *et al* (1988), pp57-9.

37 Chandler (1962), p309.

38 See, for example, Galbraith (1973, 1977).

39 Marsh *et al* (1988), pp45-8 and 60.

40 For a defence of neoclassical microeconomic theory in these terms, see, for example, Machlup (1967), pp2-4.

41 Bromiley (1986), pp3-5.

42 Bromiley (1986), p158. Bromiley's key finding is that investment is determined by sales and income; p154.

43 For a summary, see Marsh *et al* (1988).

44 Bower (1970), pp286-7.

45 See, for example, Bresnen (1991), p248, who wonders whether the root of problems lies in the way in which project aims and management procedures are formulated initially.

46 Higgin *et al* (1965), p33.

47 National Economic Development Office (1978), p2.

48 Natonal Economic Development Office (1983) in particular, with its focus on the time taken to procure new industrial buildings in the UK, may be seen as a direct response to Slough Estates (1976, 1979) which suggested that the industrial building process was lengthier and more problematic in the UK than in many of the UK's major international competitors.

49 National Economic Development Office (1983), Chapter 9.

50 Hillebrandt and Cannon (1990), pp24-7.

51 Recall the distinction in section 1.2.4 above, and see footnote 12 to chapter 1.

52 In the Times 1000 for 1991/92, they were only 2 companies in the top 250 UK companies for which property was listed as a main activity.

53 Fothergil *et al* (1987) argue that most speculative industrial development is in units of less than 2,500 sq.m. which are more suited to small firms who traditionally look to rented accommodation to provide their building needs (chapter 3 and pp56-61; see also Department of the Environment, 1986).

54 Kelly *et al* (1992) note that the terms 'brief' and 'briefing' refer generally to

> "the ongoing process of eliciting and documenting the requirements of clients at various stages during the design of a building project" (p1).

55 Newman *et al* (1981) and Salisbury (1990) consider briefing as an architectural function; Kelly *et al* (1992) provide a review of briefing in the context of models of the design process and from a building design perspective, pp5-12.

56 Although the term 'procurement' is used generally to mean the process by which a building is obtained, in this section it refers to the formal contractual and organisational methods used to procure a new building.

57 Nahapiet and Nahapiet (1985a), p225.

58 Construction management is used here as a generic term referring to the management of the building design and construction process.

59 Cherns and Bryant (1984), pp 179-183.

60 Cherns and Bryant (1984), p180-1. Eccles (1981) uses the concept of the 'quasi-firm' to describe the organisation of contractors and sub-contractors at the core of a building project.

61 Morris and Hough (1987), p239.

62 Walker (1989), chapter 9, table 9.1.

63 Morris and Hough identify three generic forms of project organisation: functional, project and matrix (1987, pp238-240. For a review, see Bresnen (1990), pp51-67.

64 HM Treasury (1986), pp16-20.

65 Walker (1989), pp65-7.

66 Walker (1989), pp71-7, and pp134-141.

67 Walker (1989), pp57-60, and pp113-115. See also British Property Federation (1983).

68 See for example, Brandon and Powell (1984).

69 See for example, Cyert and Hedrick (1972), pp398-400.

CHAPTER 3: IMPLEMENTATION AS A RESOURCE ALLOCATION PROCESS

3.1 INTRODUCTION AND OVERVIEW

This chapter describes Bower's (1970) process model which has been used to study management action during capital investment decision making and implementation. It begins with an overview of the model introduced in chapter 2 and proceeds to a critique including a discussion of the model's significance to the present study. Thereafter the discussion concentrates on some of the implications for an examination of the research problems in terms of the model, and concludes with propositions for research.

3.2 THE RESEARCH MODEL

3.2.1 Overview and recent developments

Bower (1970) examined four separate investment projects in a large diversified firm in the USA. The model derived from this investigation describes the resource allocation process in terms of three sub-processes: definition, impetus, and determination of context. Each of these processes can be broken down into three distinct phases: initiating, integrating, and corporate; each of which occur at different hierarchical levels in the corporation. The model is illustrated diagrammatically at Figure 3.1 below. Its processes and phases are described in detail in the following sections.

The significance of Bower's model to the present study stems in part from its multi-layered description of the investment process wherein investment is described in terms of the activities undertaken, the sequence of events and the level of hierarchy involved. Further, it depicts simultaneous as well as sequential activity and allows a connection to be made between project-level activity and wider corporate strategy (Burgelman, 1983)[1]. Because of its richness, it will be seen that the model offers potentially useful insights into the way in which firms obtain new buildings as part of the resource allocation process.

Figure 3.1 Bower's model of resource allocation

Process Phase	DEFINITION	IMPETUS	DETERMINATION OF CONTEXT
CORPORATE	Aggregate, Financial Company – Environment	Yes or No	Design of Corporate Context
INTEGRATING	Financial Aggregate ↓ | ↑ Product Market Strategic	The company "wants" ↓ | ↑ The businesses "want"	Corporate needs ↓ | ↑ Subunit needs
INITIATING	Strategic Product/Market	I've got a "great" idea	Product/Market not served by structure.

Bower (1970)

Bower's scheme charts the identification and development of investment projects in terms of three processes: project definition, impetus and determination of context. These processes have different phases associated with them which are broadly related to hierarchical levels within the firm: initiating, integrating and corporate.

Bower argued that the process by which capital investment projects were defined (definition) was initiated by lower level managers within the divisions whose concerns were production or 'facility-oriented'[2]. The technical aspects of this definition were largely resolved at this level of the firm. The extent to which these potential investment projects moved towards funding depended on the support provided by middle ranking managers (impetus). Top management did not participate directly in the process but could influence it by changing the organisational context within which lower level managers operated (this process Bower called 'determination of context').

Few of the decision models reviewed in chapter 2 offer a similarly structured framework for an examination of management action during the resource allocation process. Some of these, for example, focus in more detail on the steps or activities in the decision process (King, 1975; Mintzberg *et al*, 1976; Nutt, 1984). Others offer a contingency approach depending on the nature of the particular decisions or topics (Hickson *et al*, 1986), or a more explicit consideration of the effects of environment (Berry, 1984). However, they do not consider the interrelationship between decision activities and the organisational hierarchy in the way described by Bower. This is of particular relevance because of the general lack of recognition within the construction literature of the corporate client as a complex organisation. Additionally, within this literature the emphasis on the single authoritative voice implies a strong element of top management participation in investment decision making.

Bower's model provides a well documented framework which has received much support in subsequent empirical studies of the capital investment process and indeed, of the process of wider strategic decisions (see, for example, Hofer, 1976; Bower and Doz, 1979; Ireland *et al*, 1987). Although there have been few documented exercises to corroborate the model in its entirety (notable among these are Ackerman, 1970, who examined differences between integrated and diversified companies; Schwartz, 1973, who examined high technology companies; Prahalad, 1975, and Doz, 1980, who examined multinationals), elements of the model receive considerable support across a range of disciplines. Support for or challenges to particular aspects of the model will be addressed in the detailed description which follows.

More recently, Burgelman (1983), in an examination of the transformation of research and development activities into new business ventures, used Bower's model and added a separate process of 'strategic context' to describe the strategic process of creating new business. Burgelman found less support than advocated by Bower for the use of determination of context as a controlling mechanism by top management. This issue is returned to below. A number of authors have provided general support for the model as describing capital investment in the large firm as a 'bottom-up' process of bargaining and choice spread across levels of the management hierarchy and over long periods of time, including in the USA Bettis and Prahalad (1983), Bourgeois and Eisenhardt (1988), Adler and Shenhar (1990), Fornell *et al* (1990), Schilit (1990), and in the UK Goold and Campbell (1987), Marsh *et al* (1988), Nahapiet (1988), Stopford and Baden-Fuller (1990), Butler *et al* (1991).

3.2.2 The process of definition

Bower locates the origins of investment projects in the operating levels of the firm, where a 'discrepancy' between production needs and available capacity is identified by those managers who are 'facility-oriented', ie plant managers, production managers and the like, responsible for production. This discrepancy is identified in response to information from specialist departments such as accounting (for example, when costs are too high), marketing (for example, when quality is too low, or sales volume is too low), research, or general management (for example, when a new product needs to be developed).

Between identifying such a discrepancy and submitting a proposal to top management for funding approval, the project gets defined (to some degree). The task of project definition was observed by Bower to have three distinct phases, each occurring at different levels across the organisation's hierarchy.

The discrepancy triggers an 'initiating phase' of the definition process. Bower located this in 'the product/market oriented sub-units' of the corporation. Here, the project begins to get defined in terms of productive capacity required, expected output, time of availability, cost, and so on.

At a higher level in the hierarchy there will be concern about aggregate financial performance, dividend policy and other matters such as government policy, public and labour relations, and corporate growth. Bower called the way in which these corporate concerns shape the project definition the 'corporate phase' of the definition process. This phase is triggered by a discrepancy between a 'company and its environment.'

The existence of these two contrasting phases implies an intermediate phase, identified as the 'integrating phase.' This consists of the transmission of the need for aggregate earnings downward in product-market terms to those who are concerned with product-market strategies, and the transmission of the need for resources upwards in financial terms to those concerned with corporate planning (Figure 3.1). This phase is triggered by a discrepancy 'between the plans of the sub-unit parts and the corporate whole' and is concerned with managing the 'part-whole' relationship[3].

Although three distinct phases of the definition process were identified, definition is largely a technical and economic process (King, 1975; Burgelman, 1983) where the initiating phase is the primary determinant (see Figure 3.2 below). The discrepancy identified by facility-oriented managers constitutes the main source of project definition.

3.2.3 The process of Impetus

Once a project proposal begins to be defined, it must progress up the hierarchy of the organisation, passing through intermediate stages of approval before final authorisation by top management. Bower found that the rate at which a project does this depends on the "impetus" given to it. Impetus is defined as the force which moves a project toward funding, a largely political process involving commitment to, and sponsorship of, the project by managers at successively higher levels than that from where the project originates.

In an earlier work, Aharoni (1966) described the process by which managers make commitments to investment proposals which accumulated into personal and organisational 'stakes' on a proposal's success. He argued that such commitments were created through routine activities, such as collecting information, when

> "...it is necessary to communicate with people, to make certain decisions, and often to give tacit promises. In this process commitments are accumulated until a situation is created which leads inevitably to investment."[4]

As with the process of definition, Bower describes impetus in terms of three distinct phases: initiating, integrating and corporate. The initiating phase involves the launch of the project as a proposal for funding - "Someone says 'I've got a great idea', and means it". The corporate phase is the ultimate stage of approval or rejection. Between these phases comes the necessary sponsorship by those managers whose 'position and reputation give them the power to move projects to funding'[5]. This integrating phase is the primary determinant of impetus, the source of which lies in intermediate levels of the corporation (Figure 3.2).

This analysis is not unique to Bower, for King's (1975) 'transmission' is analagous to Bower's impetus (see section 2.3.4 above). The idea of a socio-political process which moves major investment and/or strategic decisions towards funding receives much support in the literature (for example, Quinn, 1980; Schilit and Locke, 1982; Burgelman, 1983; Shrivastava and Grant, 1985; Hickson *et al*, 1986; Schilit and Paine, 1987; Marsh *et al*, 1988; Schilit, 1984, 1990; Fornell *et al* 1990; Chenall and Morris, 1991).

3.2.4 The forces shaping definition and impetus

Bower argued that the way in which projects were defined and moved toward funding could be expected to be influenced by the corporate structure within which these processes take place. This leads to his central proposition that managerial behaviour may be influenced by top management who can change the corporate structure under their control - the formal organisation including the measurement, reward and punishment structure - and within which lower level managers operate.

The relationship between strategy, structure and business performance has become a dominant theme in the strategic management literature, typified by the work of Rumelt (1974) and Miles and Snow (1978). However, the use of structural context to influence behaviour is the most problematic and controversial of Bower's findings. First, this is because Bower sought to identify improvements in the investment process. This requires a prior view of what constitutes desirable behaviour (Berry, 1984). In particular, Bower assumes a congruence of corporate and personal goals among 'purposive managers' (a concept based on Simon's 'intendedly rational' man; see Simon, 1957) who are guided by a structure which helps them relate both sets of goals. This point is returned to in section 3.3.8 below.

Secondly, although there is support within the literature for the deliberate use of structure to influence managerial behaviour (for example, King, 1975; Cohen, 1983; Adler and Shenhar, 1990; Gupta and Govindarajan, 1991), other authors argue that the alteration of structural context is a crude and slow-working influence for individual projects (Burgelman, 1983; Bart, 1986; Marsh *et al*, 1988). In attempting to establish whether top management play an active part in the investment process, attention will also be paid to the possibility of direct intervention (Marsh *et al*, 1988).

3.2.5 The process of determination of context

Bower called the corporate structure which influences the sub-processes of resource allocation 'context', and distinguished between 'structural context' and 'situational context'. The former is described by the corporation's formal structure, that is, the information, control and measurement systems for both business and managerial performance. The latter includes the personal and historical circumstances of individual managers and projects. Situational context is important but unique to each particular situation. Bower considered it not amenable to generalisation and therefore left it out of his model[6].

Figure 3.2 The resource allocation process as observed

Level	Phase	DEFINITION	IMPETUS	CONTEXT
Corporate Group	Corporate			Primary Determinant
Division	Integrating		Primary Determinant	
Area Product Group	Initiating	Primary Determinant		

Bower, (1970)

There is a separate process by which structural context itself is determined. Bower considered this 'determination of context' to be the third sub-process of resource allocation. It has three phases, the most important of which is the corporate phase involving the choice of a new structure. The initiating phase indicates a discrepancy between strategy and results which is attributable to structure. The integrating phase is again concerned with the 'part-whole' relationship. This involves exploring the relationship between structure and business performance and recommending appropriate structural revisions.

3.2.6 A summary of the descriptive scheme

The model describes the process of resource allocation in terms of three important sub-processes:

1 definition, which determines the economic and technical content of investment projects;
2 impetus, which determines which projects come to pass;
3 determination of context, which shapes the definition and impetus processes.

Each sub-process may be examined in terms of 3 phases:

A initiating, involving identifying opportunities and needs at the business level of the organisation;
B corporate, concerned with aggregate financial needs and decisions;
C integrating, which translates the need for corporate earnings into the needs and opportunities of business sub-units, and vice versa.

The model describes resource allocation as a complex process spread across many levels of the firm. Because many of the key elements of the process are widely dispersed, the need for an integrating role to manage the 'part-whole' relationship is defined. Although it is the descriptive framework of Bower's scheme which is relevant to this thesis, consideration of Bower's prescription for resource allocation brings into sharp focus the role of the integrating manager.

Bower's central proposition is that top management can influence managers' behaviour in desired directions by manipulating structural context. An essential element of structural context is measurement of performance. Therefore, before organisational structure is changed, information on the degree to which the resource allocation process is, or could be, producing desired results within the existing structure is needed.

Integrating managers, with their intimate knowledge of the strategic aspects of a variety of product-market sub-units, play a critical role by providing measurements of performance on which changes to structural context may be based. Even in the determination of context, where the corporate phase is the primary determinant, integrating managers perform a vital function. A key proposition for exploration in the present study concerns this integrating role in the implementation/construction phase of capital investment projects. This is discussed in the next section.

3.3 IMPLEMENTATION AS A RESOURCE ALLOCATION PROCESS

3.3.1 Resource allocation and the construction process

The process of resource allocation described by Bower ends with approval of a Capital Appropriations Request (CAR) by top management. Resources have been allocated, or rather, authorisation for the allocation of resources has been granted. At this point a project is defined in technical and financial terms. Although construction firms are likely to have been involved in project definition - at least to the extent which enables the building required to be costed to the accuracy normally expected in a CAR - the model does not accommodate their contribution.

The model and a good deal of the literature treats implementation as a separate process, occurring after approval of a proposal for funding. For that part of the project concerned with the procurement of a new factory, implementation involves constructing a building of the scope and within both the limit of expenditure and the timescale defined in the CAR.

However, largely because the firm's requirements may change during this process, the present study considers management action during implementation in terms of the key sub-processes in Bower's model. This will help explore the utility of the model as a description of how the firm's management ensures that the new building procured is suitable for their firm's needs.

3.3.2 The process of redefinition

The nature of uncertainty surrounding the definition of the manufacturing firm's building needs has already been noted (chapter 1, section 1.3.3)[7]. Because of this uncertainty and the time taken to construct a new factory, it may be expected that the firm will monitor its requirements against project definition during implementation to help ensure that it gets a suitable building. Indeed it must do this or accept that the definition contained in the CAR will constitute the sole definition of the project, even though the requirements might have subsequently changed.

The process of monitoring, assessing and, if necessary, changing project definition during implementation involves prediction, analysis, definition and review or confirmation of viability, and is essentially part of an ongoing resource allocation process. More specifically, the process of redefining the project may be considered in terms of the process of definition in Bower's model. It will be triggered by a discrepancy between anticipated production needs and planned capacity. In the language of the model, the discrepancy will be identified by those whose concerns are 'facility-oriented' in response to information from specialist departments monitoring the firm's environment (for example, marketing might indicate that the initial forecasts were too low; or research might identify advantages of a new product or production process).

3.3.3 The process of incorporating change

When the change needed is of such a nature that approval by top management is required, the proposal for change will need sponsorship at successively higher levels than where it originates. The process of getting projects changed may therefore be viewed in terms of the process of impetus in Bower's model.

However, an additional, critical factor is present when the project is being implemented. As well as obtaining top management approval for such change, the participation and co-operation of construction firms must also be obtained. During implementation, then, impetus is about the firm's management of external as well as internal processes.

3.3.4 An outline scheme for project implementation

It is now possible to consider Bower's model as a framework for the examination of management action during project implementation (see Figure 3.3 below). The processes of redefining the project and incorporating changes may be described in terms of the model's sub-processes of definition and impetus. The initiating phase is the primary determinant of redefinition: as with definition, a discrepancy identified by facility-oriented managers which triggers this process is expected to constitute the main source of project redefinition. The integrating phase is the primary determinant of the process of changing projects.

Figure 3.3 An outline model of resource allocation during implementation

Process Phase	DEFINITION (Redefinition)		IMPETUS (Implementing change)		DETERMINATION OF CONTEXT	
CORPORATE	Aggregate, Financial Company – Environment		Yes or No		Determine/agree structural context	
INTEGRATING	Financial Aggregate ↓	↑ Product Market Strategic	The company "wants" ↓	↑ The businesses "want"	Corporate needs ↓	↑ Subunit needs
INITIATING	Strategic Product/Market (Will product/market needs be served by the new building?)		I've got a "great" idea (The original idea needs to be changed)		Product/Market not served by structure	

After Bower (1970)

An important proposition arises here: it is that some of those managers who decide to sponsor change to a project's scope are likely to be the ones who will implement it. This is consistent with the model where top management do not actively participate in the process of resource allocation. This raises questions about top management's indirect role, and the motivating forces behind the commitment of lower level managers. These will now be considered.

3.3.5 The forces influencing redefinition and the incorporation of change

The importance of managerial commitment to impetus has been noted above. Bower found that the extent to which managers believed the forecasts, etc, on which projects were based influenced their personal commitment to obtaining approval. Indeed, given the level of commitment required to move investment projects towards funding, it may be argued that projects become harder to reject the higher up the management hierarchy they progress. However, in the context of change during implementation, such commitment may be somewhat double-edged. Changing projects during implementation may reflect poorly on managerial judgement[8]. For this reason, managerial commitment may be as great a force resisting change as it may be in implementing it.

The model considers structural context in terms of its influence on the processes of decision making, bargaining and choice which occur within the firm. The involvement of construction firms outwith the corporate structure raises the question of whether structural context can also influence these agents. This will now be addressed.

3.3.6 The role of structural context

With the concept of the 'temporary multiorganization' (Cherns and Bryant, 1984), construction firms may be seen to come within a 'structural context' which may influence the way in which projects get implemented and/or changed. More particularly, the formal contractual and management arrangements between the client firm and construction firms for the supply of the new factory create a form of 'structural context', in that they determine a punishment and reward structure, flows of information and control mechanisms between organisations[9]. Such context may be considered 'structural' (as opposed to 'situational') in that formal contracts will come into being, at least for the duration of the construction project.

In terms of the model, the tasks of selecting, negotiating and placing consultant's commissions, project management arrangements, construction contracts, etc are all part of a process of determination of context. However, this process may be distinguished from that observed by Bower in at least three ways.

The first is that, although these agreements may be determined in the client firm's interests, they have tended to become standardised along lines which arguably reflect construction's need as much as, if not more than, client requirements (see for example, British Property Federation criticisms of traditional procurement arrangements, British Property Federation, 1983). But it is this standardisation rather than any inbuilt bias which may inhibit attempts to determine such context in the client firm's interests (see for example, Royal Institute of Chartered Surveyors, 1982).

Secondly, because these agreements have a limited life, the extent to which they may be adjusted to influence behaviour in desired directions may be limited. The relatively short duration of building contracts, for example, may make it difficult to assess the relationship between the client's criteria and construction's performance on which changes to this structural context may be based. Indeed, as in the case of Bower's 'context', an explanatory theory relating different forms of building procurement arrangements to particular client requirements is still a goal for research (Brandon *et al*, 1988; Kelly *et al*, 1992). In any event, the financial effort involved in changing these arrangements once they have been agreed may be punitive and a successful outcome is far from certain.

Thirdly, the kinds of arrangements being discussed here arise relatively infrequently. Opportunities to influence future behaviour may thus be rare. The process of determination of context in Bower's model is initiated by a discrepancy between "strategy and results that is attributed to structure"; ie context is adjusted after poor performance[10]. In the present study, however, the emphasis is on the prior determination of context in the expectation that behaviour may need to be influenced in a desired direction.

In summary, structural context is considered important during implementation, both because it may facilitate change to project definition and, perhaps more importantly, because it may constrain it. The point has been made previously that the very act of implementing projects through time makes change to project definition progressively more difficult. Personal commitment and contractual arrangements may constrain changes to project definition, but both are necessary if the firm is to obtain a new factory of the kind needed. A descriptive framework of the process by which the firm ensures that it gets the building it needs must consider forces which enhance *and* constrain managerial ability during implementation.

3.3.7 Assumptions about behaviour

Underlying the concept of determination of context (and the other sub-processes of resource allocation) in Bower's model are assumptions about corporate objectives and about behaviour in business organisations. Bower assumes that the corporation is a 'purposive' institution whose objectives are primarily growth in the earnings stream. Managers are also purposive, pursuing wealth and power goals. Personal and corporate goals are closely linked by structural context.

To attempt to apply this model to the implementation phase of capital projects is not to eschew completely the behavioural attack on the theory of the firm - indeed the model explicitly recognises the existence of coalitions of diverse individuals within the firm and the likely internal goal conflict which may arise (Cyert and March, 1963). However, in Bower's model such internal goal conflict may be resolved via a process of integration whereas Cyert and March argue that goals are attended to sequentially. Carter (1971) argues that Bower's model recognises the importance of organisational hierarchy, and that this has the effect of 'filtering' sub-unit goals. Further, whereas Cyert and March were concerned with operating decisions, Bower and Carter were concerned with strategic decisions which are likely to involve more people at more levels in the organisation[11].

Further, the present study does not begin with an assumption that sub-unit and corporate goals are the same nor is it motivated by the need for prescription. Berry (1984) argues that because Bower attempts to prescribe improvements for the management of resource allocation, assumptions about managerial behaviour were required which led to a consideration of capital investment as a "decomposition of an imputed top management role"[12]. However, the propositions outlined below permit an exploration of the use of structural context; they do not require that sub-unit and corporate goals be aligned as a precondition to help describe management action. Indeed, other challenges to structural context as a mechanism whereby such goal alignment may be achieved have already been noted, which admit the possibility of a more direct top management role.

3.3.8 Conclusion

The foregoing discussion has outlined the potential usefulness of Bower's model as a framework within which management action may be examined during the decision and implementation stages of capital investment projects. The concepts of definition, impetus and determination of context may provide useful insights into how the firm's management ensures that a suitable new building is obtained, particularly when requirements change.

Redefinition is a process of identification, measurement and analysis; a largely technical/economic process which determines options for the redefinition of the project but does not, of itself, change it. The process of changing the project is primarily a political/managerial process, involving 'integrating level' managers who will either have delegated responsibility to sanction the change themselves, or will present a case for change to top management. These managers will perform the role of construction 'client'.

Much of the discussion has focused on the implementation of change to the project during construction. This is not to imply that the need to change the project must arise before the firm acts to ensure it gets a suitable new building. Rather, the possibility of change is all that is required. And this is present in most, if not all, factory building investment projects. Ensuring that a suitable building is procured is as much about confirming that the original project definition is robust as it is about changing it.

In the terms of the model, those 'integrating level' managers who provide impetus by reconciling corporate requirements with sub-unit needs will also reconcile both of these with the needs of construction firms to get projects implemented. A need for integration[13] of their respective project needs may therefore be defined between the client firm and construction firms during implementation.

The structure within which managers operate may be expected to influence the way in which projects get implemented, redefined and changed. This includes the arrangements between the client firm and construction firms for the supply of the new building. There is a separate process by which this latter 'structure' in particular is determined. A question for research is whether particular attention is paid to this, given the limited extent to which this structure may subsequently be adjusted. The study propositions can now be stated.

3.4 RESEARCH PROPOSITIONS

3.4.1 Restatement of the research problems

The problems identified in chapter 1 will now be rephrased to enable useful propositions for research to be identified. In the model and in much of the literature, implementation is treated as a separate process from investment which occurs after approval of a proposal for funding. No allowance is made for how the firm may manage the contribution of construction to:

1 the process of defining building needs (facility definition);
2 the process of moving investment proposals towards funding.

Similarly, little attention is paid to the way in which change to facility definition is incorporated, either:

3 following submission of an investment proposal but prior to final authorisation;
4 following final authorisation and, especially, once construction has started.

3.4.2 Study propositions

The process of definition

The first proposition concerns the involvement of the construction industry in facility definition prior to the submission of an investment proposal to top management:

A In the large diversified firm the process of definition occurs across many levels of the management hierarchy and involves input from construction firms outwith the corporate structure.

The integrating phase in the definition process reconciles the need for corporate earnings with the needs of individual businesses. But both these sets of needs must also be reconciled with questions of what can be built, how, where, when, and at what cost. This is a further complication to the integrating phase activity but a necessary one. Although the main source of facility definition is to be found in a discrepancy identified by facility-oriented managers,

B The process of definition will be managed as an 'integrating-phase' activity by managers to whom the firm will delegate its responsibility as construction client.

Note that neither business-level managers - who define what facilities are needed - nor top management - who determine what investment funds are available - necessarily have a direct role in representing the firm as construction client.

The process of impetus

Bower found that impetus was generated by the commitment of managers who had an interest in ensuring the success of the investment proposal. Prior to submitting the investment proposal to top management for funding approval,

C Managers with responsibility as construction client can use the involvement of construction to help generate impetus, in particular, by:

i) requiring expenditure on the project prior to final authorisation by top management;
ii) making the achievement of project objectives - for example as to cost or timing - contingent on an early approval of the proposal.

Changing project definition prior to funding approval

Following the submission of a proposal for funding, the likelihood that the project or facility definition will be substantially changed or rejected through the intervention of higher level managers becomes less the more impetus it gathers. This is partly due to the impetus already accumulated, and partly because the information necessary to change definition is often available only to facility oriented managers lower down the hierarchy.

D The original perception of a discrepancy identified by facility oriented managers will constitute the sole source of facility definition unless explicit steps are taken higher up the management hierarchy to introduce other issues.

The role of top management

Bower found that top management did not participate directly in the resource allocation process. However, they could influence the process indirectly by manipulating the organisational structure within which managers who were involved more directly in the process operated.

E Top management's direct role in the definition of facilities is restricted to a budgetary/financial sanction.

F Top management can influence facility definition indirectly by manipulating the structural context within which lower level managers operate.

Getting facilities built

Following final authorisation by top management, project definition does not cease. Despite construction involvement prior to this, the facility will only have been defined in terms sufficient for an assessment of feasibility. The focus of facility definition will now be on refining what has already been defined within the limit of expenditure in the investment proposal. If top management's direct role in the definition of facilities is financial - ie if proposition E is supported - then

G All aspects of facility definition - except the limit of expenditure in the investment proposal - may be changed without top management approval.

H Those integrating-level managers with responsibility as construction client will manage the facility definition process to help ensure that the building required is obtained within the limit of funding available.

Major change following funding approval

However, the source of change to project definition will continue to be found in a discrepancy identified by 'facility oriented' managers. Particularly where such change requires more funding than authorised by top management, considerable impetus will be needed to obtain it. The implementation of change can involve considerable managerial effort, depending both on the nature and extent of the change and when in the construction project it is to be introduced. It follows from proposition B above that the implementation of this change is an integrating-phase activity.

Where the likelihood that major change will be needed during construction is high,

I Integrating-level managers with responsibility as construction client will determine a form of structural context between the firm and construction to facilitate the incorporation of change.

3.5 CONCLUSION

The study propositions follow directly from a consideration of management action in terms of Bower's resource allocation model. The model and propositions are concerned with the process by which the large firm allocates scarce resources to purchase capital assets. In particular, the model emphasises the investment 'decision' as a process taking place across many levels of the corporate hierarchy.

In so far as is known, no serious exploration of the process by which the large manufacturing firm obtains a new factory has yet been undertaken within this framework. Indeed, as has been argued in chapter 2, the construction literature lacks a focus on the corporate client and little attention is paid to the client perspective. This thesis therefore explores some of the implications of empirical studies of the capital investment process for the way in which corporate clients make and implement industrial building investment decisions.

Rather than testing the validity of the propositions however, the primary concern is with examining whether they offer useful explanations for management action during the decision and implementation stages of capital investment projects. The next chapter outlines the research design and discusses methodological issues involved in developing a research strategy which can adequately explore these questions.

3.6 FOOTNOTES

1 Burgelman (1983), p229.

2 Bower argues that the responsibility for facilities is usually assigned to production managers, plant managers or engineers. 'Facility-oriented' is defined to mean

> "that those aspects of such jobs which are measured and for which the manager holding the job is rewarded or punished, have to do with aspects of a facility."(1970, pp 48-9).

3 All quotes in this section, see Bower (1970), pp74-7.

4 Aharoni (1966) in King (1975), p74.

5 Bower (1970), pp77-8.

6 See Bower (1970) pp71-2, 276-8 for a discussion of situational context.

7 Capital investment decision making is characterised by a high level of uncertainty concerning almost all aspects of the decision, for example market knowledge, technology, the costs and availability of financial and other resources, and so on (see for example, Kennedy and Sugden, 1986, pp34-5).

8 See for example, Goold and Campbell (1987), Chapter 1.

9 These are the main elements of structural context as Bower defines it (1970, p71).

10 Bower (1970), pp78-9.

11 Carter (1971), p421.

12 Berry (1984), p79.

13 Lawrence and Lorsch have defined integration as

> "the quality of the state of collaboration that exists among departments that are required to achieve unity of effort by the demands of the environment" (1967, p11).

This definition embraces both the process by which the state (of collaboration) is achieved and the organisational devices used to achieve it, as well as the state itself. Such collaboration may be expected to include both explicit 'structural' devices (ie structural context, in the language of Bower's model) and implicit 'political' ones (eg the interpersonal skills of managers).

CHAPTER 4: METHODOLOGICAL ISSUES

4.1 INTRODUCTION AND OVERVIEW

This chapter focuses on the research strategy and methods used to examine the study propositions raised in chapter 3. In particular, attention is paid to the exploratory nature of the research and the use of qualitative techniques for data collection and analysis. The selection of cases and the detailed research method are described and the discussion concludes with a description of how the cases are reported in chapters 5 and 6.

4.2 STRATEGIES AND CHOICES: THE IMPORTANCE OF PROCESS

4.2.1 The nature of the enquiry

Chapter 2 developed the argument that the construction literature, with its prescriptive orientation and its characterisation of the unitary client, lacks a conceptual scheme to examine the research problems from the corporate client's perspective. This discussion was extended in chapter 3. There, Bower's resource allocation model was examined as a potentially useful framework for addressing research problems arising from consideration of the literature on capital investment decision making and construction management.

In particular, the model suggests propositions for research which direct attention to key features of the decision and implementation stages of capital investment projects. It also provides a framework for analysis. Although well documented, and tried in the corporate strategy area in particular (see for example, Burgelman, 1983), Bower's model has not been used for an examination of the questions addressed in this research. In the present study the propositions are used in an attempt to explore the process by which the large manufacturing firm makes and implements capital investment decisions as part of resource allocation.

Used in this way, the model offers a conceptual scheme rather than a quantitative or symbolic device which the term normally connotes. It is the descriptive nature of the model which is of benefit here in representing the human and organisational terms of the complex process of resource allocation which are not easily examined quantitatively.

For these reasons, the research strategy chosen was the intensive, case-based approach in the tradition of Bower (1970), King (1975), Burgelman (1983), Cherns and Bryant (1984), Marsh *et al* (1988) and Butler *et al* (1991), for example, with a consequent emphasis on qualitative research techniques.

4.2.2 Approaches and choices

Although some studies of corporate decision making have used broadly based surveys (for example, Mintzberg *et al*, 1976; Hickson *et al*, 1986), the case-based approach with its focus on a small number of firms was particularly appropriate here for a number of reasons. First, there has been no accumulation of research evidence on the corporate client role in construction projects which would allow the concepts in question to be refined or the complex features of interest to be conceptualised in a form which makes them amenable to quantitative analysis.

Secondly, the argument developed up to this point lays considerable stress on the capital investment decision as a complex process occurring over many levels of the corporate hierarchy and over long periods of time. The need for multiple informants and other sources of information to examine this complexity (which can be accommodated within the case study approach and, indeed, is a feature of it; Yin *et al*, 1983) is not well served by 'broadcast' survey methods with their emphasis on single respondents, pre-determined questions and ready structured responses.

Thirdly, the potential influence of the organisational structure and of the firm's wider business environment has been noted. A means is needed by which the investment decision and implementation processes may be examined in their natural setting. The case study approach permits a consideration of the organisational and business context within which investment decisions are made and implemented. Its potential for this type of in-depth analysis is an important element in its choice for the present study.

4.2.3 The case study approach: tradition and point of departure

While the case study has a long tradition in political science and social anthropology (Mitchell, 1983[1]), it has only recently been used within the business administration area. Within the construction literature, case studies have tended towards the illustrative rather than the descriptive or analytical. However, recent research in construction management has utilised the case study method to focus on problems of project organisation and interrelationships between project participants (for example, Lansley *et al*, 1979; Walker and Hughes, 1984; Bresnen, 1986, 1988; Dodd and Langford, 1990).

The chosen research strategy departs from that adopted by the many studies which utilise a longitudinal approach based on direct or participant observation. Although the longitudinal element was important, the author was unable to adopt the role of either participant or direct observer. When fieldwork was undertaken the author was employed in a national construction consultancy. No projects on which the author's firm were engaged were available as case studies, and access to projects for direct observation on which competitor consultancies were engaged could not be gained[2]. Instead, recently completed projects were sought with the aim of examining the project history through the recollections of participants and through documentary sources (Webb *et al*, 1966). The chosen approach therefore contains elements of case history[3] as well as case study method. (The criteria for identification and selection of cases are outlined below).

While the 'history' in question was relatively recent - one project had not been completed when fieldwork started, the other had been completed about eight years - aspects of the process by which investment decisions and choices are made are inevitably missed when there is no opportunity for direct observation. While this might be a limitation of the chosen approach, not even the directly-observing researcher can be in all places at once (Zelditch, 1962), and must therefore chose in advance 'events' for observation, some of which may prove to be unimportant. With direct observation there may be less opportunity for informants to 'post-rationalise' decisions and actions but a particular advantage of the case history approach is that linkages may be made in the data during collection both backwards and forwards in time. Forward linkages are not possible for the directly-observing researcher during data collection. In any event, the distinction between direct observation and a post-hoc examination of events is not so clear. There will always be elements of history in informants' accounts and, particularly, in documentary material which is likely to provide a valuable source of data for studies of the investment processes of interest[4].

Finally, there are pragmatic reasons - unconnected with the author's employment - for the choice of completed projects. Firstly, although the boundaries of the process to be examined extend from the origins of projects to the completion of construction work (see section 4.5.1 below), such origins would be very difficult to identify in advance to enable the directly-observing researcher to negotiate access in time and be present during the course of a necessarily unpredictable process[5]. Secondly, in the large firm it is likely that many possible investment projects are identified but never progress to construction projects. Tracking investment decisions in real-time could result in much abortive work. Thirdly, the decision and implementation processes may extend over many years and it may not always be possible to stay with the project for its duration.

The concentration on completed projects therefore, whilst turning on pragmatic considerations concerning difficulties associated with identifying and tracking investment projects in real time, also allows an assessment to be made of the suitability of any potential case prior to inclusion in the study. Yin (1984) argues that as case studies rely on analytical rather than statistical generalisation[6], each case in a multi-case research design is selected for a specific purpose[7]. However, to do this requires prior knowledge about the cases to be selected. As a key problem to be investigated concerns the management of change to facility definition during the decision and implementation process, concentration on completed projects enables potential cases to be identified which permit an examination of this phenomenon. The criteria for case selection will now be discussed in the context of the research design.

4.3. RESEARCH DESIGN

4.3.1 Unit of analysis

The study questions (chapter 2) and the study propositions (chapter 3) have already been identified. In chapter 1 the unit of analysis was identified as the large manufacturing firm; more precisely this may be defined as those parts of the firm - managers and personnel, taken collectively and individually - involved in the decision and implementation stages of a capital investment project. The focus is on decisions relating to the construction of a new factory building and projects involving such investment provide the setting for the investigation.

4.3.2 Single and multiple cases

The number of cases to be examined is an important methodological as well as pragmatic consideration. Access was expected to be a particular problem for intensive internal studies of the decision processes of large firms. (Indeed, around the time when access was being negotiated, revelations in the mass media concerning management malpractice in a number of large UK firms[8] contributed to firms' wariness of approaches for internal studies; see section 4.4.2 below.) However, the circumstances in which a single case is generally felt to be appropriate (the critical or deviant case: Hakim, 1987; or the revelatory case: Yin, 1984) did not apply on the present study. Hakim argues further that, for a small number of cases, there is an advantage in selecting cases to cover the likely range in variation which may be expected, perhaps starting with the extremes[9].

The approach then was to select two cases for study and to utilise the opportunity for comparison and contrast by selecting cases between which differences were to be expected with respect to the key propositions and features of interest. A key problem to be investigated concerns how the firm copes with uncertainty over facility definition and change arising during the decision and implementation stages of resource allocation. Clearly the occurrence of major change to facility definition may be expected to pose problems for those integrating-level managers with responsibility as construction client. Although much would depend on the nature and scope of the change and when in the process it arose, generally in such a case it may expected that propositions D and G to I (in section 3.4.2 above) would be particularly helpful in exploring the action of those integrating-level managers in ensuring that a suitable new building is obtained. Conversely, a case where facility definition was determined early in the definition process and did not alter substantially throughout its subsequent development and construction would provide a contrary perspective. In particular, this would allow a consideration of how useful are propositions D and G to I in exploring management action in circumstances where the possibility of change existed but did not occur (see section 3.3.8 above).

One case was therefore sought where major changes to facility definition occurred throughout the definition and construction processes. A second case was sought where such change did not occur. As will be seen, the cases finally selected differed from each other in a number of other respects, in particular in the extent to which the resource allocation process took place across the corporate hierarchy and over time. Although it was expected that no two cases selected for study would have similar organisational or temporal characteristics, the differences noted have provided additional opportunities for discussion and analysis and are particularly relevant to propositions A to C and E to F.

4.3.3 Criteria for case selection

Although the search for case studies concentrated on identifying completed factory building projects in the first instance, criteria for the selection of cases related primarily to the large manufacturing firm as the unit of analysis. Put simply, the aim was to identify large manufacturing firms which had a divisional structure and had recently constructed a factory building for their own use as a production facility.

It was necessary to make these criteria operational to enable suitable firms to be identified. This was not to define a 'population' of large manufacturing firms from which a sample might be drawn; there is no attempt made in the analysis of case material to relate study findings to a wider population. Rather, given the need to select cases of interest, and the problems which were expected with access, criteria were defined to help identify sufficient potential cases from which a final selection could be made.

The task, then, was to identify large diversified firms involved in 'manufacturing', which was taken to mean those activities within divisions 2, 3 and 4 of the Standard Industrial Classification (Central Statistics Office, 1986), excepting the extraction industries (classes 21 and 23). Secondly, firms were considered large if they came within the top 250 firms in the 'Times 1000' (The Times, 1988) listing, which helped provide a recognised measure of 'largeness'[10].

The criterion of diversification is rather more difficult to make operational than those concerning size or the nature of activities. As investment projects were required which arose from the divisions so as to explore the questions of interest, firms with a divisional structure were therefore needed as case study hosts. Channon (1973), drawing on Wrigley (1970) and Scott (1971) has identified three categories of structure: functional, multi-divisional and holding company. The important distinction here is between the functional form, which is characterised by a collection of specialised functions organised hierarchically under the office of a chief executive, and the multi-divisional or holding company forms, which are characterised by collections of autonomous operating divisions and/or subsidiary companies controlled by a corporate office. The extent to which the relationship between the corporate centre and the sub-units will vary depending on the extent of diversification, international scope and size is of less interest[11].

As well as arising from the divisions, investment projects were required which needed the approval of top management. Additionally, in the tradition of Bower (1970), Carter (1971), King *et al* (1975), Burgelman (1983), Marsh *et al* (1988) and Butler *et al* (1991), for example, investment projects were sought which were of sufficient scope to involve the firm concerned in a major strategic investment. A distinction may be made between investment decisions which are concerned with the firm's ongoing business activities, and the more discrete investment decisions of strategic consequence. Bower (1970) defines the former as belonging to the process of 'routine' change and the latter to the process of 'critical' change. Such critical change involves business planning, which is defined as the selection of market opportunities and the identification of products required to serve these markets and investment planning, involving the selection of investment projects to generate the products required to be sold in the chosen markets[12]. The investment projects of interest to this thesis were expected to arise from these critical business and investment planning processes.

Criteria relating to the structure of the firm and the significance of the investment project could only be satisfied following discussion with the potential case study host. The tactics for identifying potential case studies will now be discussed.

4.4 IDENTIFICATION OF CASE STUDIES

4.4.1 Identification

There were two possible approaches to the identification of case studies meeting all these criteria. The first was to identify firms which met the initial selection criteria relating to activities and size and to establish whether these had recently undertaken capital investment projects of the kind required. This suffers from the disadvantage that the initial approach to the firm is of a general nature, without a project to focus it. A more project-centred approach was preferred involving identifying completed industrial building projects and then establishing whether the sponsoring firms could satisfy criteria relating to activities undertaken, size and structure. Provided individual managers involved in particular projects of interest could be identified, this second approach offered a greater likelihood of success and was therefore adopted.

A means was therefore required by which completed industrial building projects and their sponsors could be identified. Some of the construction periodicals regularly publish details of different kinds of building projects to help their largely 'trade' readership identify sales and other business opportunities. Clients, consultants and contractors may be identified, together with the type, location and value of the project. Projects identified are usually at planning stage or about to go to tender. It was assumed that, given a likely cycle of planning approval, design, tendering and construction of between one and two years, details of projects appearing in periodicals which were two years or more out of date would, in general, relate to completed projects (accepting of course that not all of the projects identified in this way would have been built). The brief details of client, consultants and contractors provided could then be used to find out more about the project and client organisation and, ultimately, to help gain access.

The starting point was to examine the Contract News Service section in 'Building', the Business Leads section of 'Construction News', and the Business Alert section of 'Contract Journal' from the beginning of 1988. Only a small number of suitable projects were identified for the period 1988 to 1989 and the search was therefore extended back through the periodicals until some 50 projects were identified. Projects for firms outside of the top 250 of the Times 1000 were rejected. As a large number of relatively small projects were identified by this means, only those projects with a construction value in excess of £1m were selected (although somewhat arbitrary, it was felt that this limit would help identify projects of importance sufficient to satisfy criteria relating to the strategic significance of investment projects).

From the initial list of 50 a shortlist of 12 was drawn up. The search was for two projects, one where major change to facility definition was incorporated and another where no such change occurred. Prior to approaching individual firms it was not generally possible to establish whether change had occurred on the projects of interest. At this initial stage the approach was simply to ensure that the shortlist reflected a range of product/markets, from the rapidly changing high-technology industries to the lower technology industries more traditionally associated with manufacturing. The 12 firms identified came from a total of nine industries as follows:

Aerospace
Industrial Electronics
Consumer Electronics
Pharmaceuticals
Food
Building bricks
Packaging
Milk processing
Engineering/defence

In a small number of cases some of the consultants and contractors involved on the projects identified were known to the author. In all cases attempts were made to find out who in the client organisation had been involved closely with the project, either through personal contact or by approaching the consultants or contractors involved.

4.4.2 Access

In seven of the twelve projects it was possible to obtain personal introductions to managers within the client organisation who had been closely involved in their projects. In all twelve cases these individuals were telephoned and given a brief introduction to the present study. For those who wished to proceed further, this was followed by a more formal request for participation in the study in the form of a letter and a briefing note for case study hosts which outlined the study, its aims and what was required of the host organisation (see Appendix A). Cherns and Bryant (1984) argue that, for a study of client organisations, a basis must exist between client and researcher for negotiating a relationship which has something to offer the client. The letter and briefing note emphasised the practical elements of the study and the benefits clients could expect from sharing in the study findings which would relate observations and analysis of their involvement in the construction process to that of other firms.

Three of the twelve firms approached initially refused access outright. Following correspondence with the remaining nine firms, the contact personnel were telephoned again to discuss possible participation. The idea was to hold face to face meetings with each manager to explain in more detail the nature of the research and to explore and negotiate what access would be required. The author was concerned to ensure that participating firms would not withdraw access at some unspecified future point in fieldwork. Face-to-face meetings were granted by seven firms, three of which were particularly interested in participation. Although contact was maintained with the other four firms and attempts made to encourage participation, each one eventually withdrew during a period of some twelve months (mid 1990 to mid 1991).

During these initial meetings, the nature of access required and that likely to be available was discussed. A sample case study ('Spectrasorb' from Bower, 1970) was presented as indicative of the kind of approach which would be adopted. All potential hosts indicated that access to top management would be difficult, if not impossible. Further, all were concerned that the author be conversant with the project before approaching other personnel within the host organisation.

It is worth noting that gaining entry to the case sites did not resolve the problem of access in one stroke; it was rather the first step in a process of gaining the confidence of those who decided to support the study progressively to enable more information and individuals to be made available (Hammersley and Atkinson, 1983). It may be noted that although these 'sponsors' gave considerably of their time and effort, access to the full site was ultimately partial in each case.

4.4.3 The cases selected

Discussion with managers involved in the three firms who had indicated an interest in the research established that in two of these - both in the pharmaceuticals industry - major changes had occurred in both the decision and implementation stages of the investment projects of interest. The most promising of these was a factory called K2A for the production of a paediatric antibiotic for Glaxo Pharmaceuticals at Barnard Castle and this was selected for study. The building project was on site when access was negotiated (May to June 1990) and was expected to be completed in August 1990. Two major changes had already occurred, one during design and the other shortly following start on site. Initial contact was made with Glaxo's project manager. The manager in the other UK-based pharmaceutical company indicated that the company would not be prepared to participate on grounds of commercial confidentiality if the study involved the Glaxo project.

The second case involved a factory called Dreadnought for the manufacture and assembly of armoured fighting vehicles for Vickers Defence Systems at Newcastle. Initial contact was made with the Vickers Defence Systems commercial director with respect to a project completed in 1986 in Leeds. However, access was not granted to the Leeds project; instead the earlier Newcastle project (completed in 1982) was offered. Initial discussions established that there were no major changes during construction and that key personnel and documentation were available for a case study.

The cases selected and the host organisations are described in considerable detail in chapters 5 and 6 below.

4.5 METHODS OF DATA COLLECTION AND ANALYSIS

4.5.1 Case boundaries

The intention is to study the investment process from the origins of projects through to the completion of construction work on site. Although the latter may be defined relatively precisely - albeit somewhat artificially - in time by, for example, the issue of a certificate of practical completion of construction works[13], the former is more difficult to identify. Whilst accepting that a project's 'pre-history' may be important to an examination of subsequent developments (Cherns and Bryant, 1984), a pragmatic approach has been adopted for the identification of project origins. Projects were taken to have commenced when, in the opinion of the majority of informants, the first deliberate steps were taken which resulted eventually in the construction of the new factory (the origins of the cases examined are discussed more fully in chapters 5 and 6 below).

4.5.2 Focus on qualitative techniques

The exploratory nature of this study together with the current status of the theoretical concepts to be used argue for a reliance on qualitative research techniques. Indeed, the focus on the management of the investment decision and implementation processes within the hierarchical organisation, and the emphasis on completed projects means that a good deal of the research material had to be obtained from people's own accounts of events and of their role in the processes of interest.

In any event, while qualitative techniques predominated, quantitative data concerning estimates, forecasts, plans etc were also used. Crompton and Jones (1988) provide a useful summary:

> "..in organizational research it is not a mutually exclusive decision between quantitative and qualitative methodology. In reality it is very difficult to study organizations without using both sorts of methods. In any event quantitative data always rests on qualitative distinctions."[14]

Semi-structured interviewing and analysis of project specific documentation as well as more general documentation relating to the organisation and project history provided empirical data on which this study is based.

4.5.3 Interviewing

Following entry to each case site, ie after the initial correspondence and the first face-to-face meeting, a depth interview was held with the author's main point of contact in each client organisation. This was loosely structured and designed to identify the nature and scope of the project, the key individuals involved - in the opinion of the informant - and the informant's own role. These interviews were not tape-recorded and lasted two and three hours (Vickers and Glaxo respectively). Notes were written up as soon as possible afterwards and descriptions of the project were ordered into a largely chronological sequence and were then structured under headings relating to groups of study propositions (see the headings in chapter 3, section 3.4.2).

The intention at this stage was not to fit this data to the conceptual scheme, but rather to begin to ask questions about the kind of data which would be required to address the propositions. This enabled questions to be identified which were used to help structure the second interview. Interview notes were sent to informants who were asked to comment in particular on apparent misrepresentations; this practice was continued throughout the study and while it helped build informants' confidence in the author (Jones, 1985, 1985a), changes requested were normally very minor, concerning details of names, dates and the like.

Both key informants had been closely involved in their respective projects; one, as client's project manager (Glaxo) and the other as commercial director who, with the chief executive, was involved in pre-project planning and in the appointment of consultants and contractors. The pattern of progressively more focused interviewing described above, where interview material was used to structure and focus subsequent interviews was repeated across five interviews with the Glaxo informant (each lasting between 1.5 and 6 hours) and four interviews with the Vickers informant (each lasting between 1 and 3 hours). Although the structure of these interviews was idiosyncratic and related to the particular project under review, an underlying common structure was obtained by the organisation of questions and interview notes under headings relating to groups of propositions.

This initial concentration on single informants was primarily to satisfy the requirement noted above that the author become well versed in project detail before approaching the informants' colleagues. Not until the first five interviews had been completed with the Glaxo informant, and four had been completed with the Vickers informant was the author permitted to approach other informants within the respective organisations.

While the picture of the project built up from these sources was inevitably idiosyncratic, this was alleviated somewhat by the generalist perspective offered by both informants. As will be seen, the Glaxo informant had a background in chemistry and considerable knowledge of the technical and regulatory aspects of antibiotic development and production as well as the detail of his own job; the Vickers informant, largely because of his seniority, was knowledgeable about the project background and the workings of the organisation as well as the detail of the specific project. Additionally, during these initial interviews, access was provided to project documentation (see below). An examination of this allowed checking and confirmation of informants' accounts; the ability to link data from different sources in this way permitted more focused questioning during subsequent interviews (Fielding and Fielding, 1986).

The majority of subsequent interviews were held with personnel from within the client organisations. During fieldwork it was made clear by both informants that access to senior management up to board level would be difficult, if not impossible to arrange. Interviews were finally requested with a further seven individuals in Glaxo, and access was granted to five. Interviews were held during 1992 and each lasted between 1.5 and 3.5 hours. Interviews were requested with a further four people in Vickers and access was granted to three. Interviews were held during 1991 and 1992 and each lasted between 1.5 and 3.5 hours. All of these subsequent interviews were tape-recorded.

Towards the end of fieldwork, the Vickers main informant retired; at that time access to interview the Vickers Defence Systems chief executive was awaited, but despite subsequent requests, an interview was not granted. The consultant project manager was also interviewed on the Vickers project. A list of the individuals from whom interviews were requested, and those with whom interviews were held is presented in Appendix B, together with the interview outlines used. These interviews were generally more structured and focused on questions of particular relevance to that individual's role on the project under review.

4.5.4 Documentary material

Access was provided to project files early in fieldwork. On both projects these contained a large amount of information which provided a rich source of data allowing corroboration of - and sometimes raising questions about - informants' accounts.

Material relating to the Glaxo project was rather more voluminous than the Vickers documentation. This included minutes of meetings of project working parties, design teams and other ad-hoc groups concerned with the Glaxo antibiotic project and the planning and construction of the K2A facility. Demand forecasts for the product together with technical details of the production process were made available, as were details of the construction procurement documentation (drawings, bills of quantities, forms of contract and agreement, etc), quantity surveyor's estimates, correspondence with construction consultants and contractors, and so on. Additionally, informants' handwritten notes of meetings and notes for the presentation of project details to superiors were also made available where these had been maintained on file. There was a considerable amount of documented communications within Glaxo - compared to Vickers - relating to the project in the form of memoranda and electronic mail hardcopy. Meeting minutes were detailed, frequently amounting to more than 10 pages of closely spaced type for each meeting. In general, access was not granted to personnel or documentation higher than the Project Team (see figure 5.3 in chapter 5 below); however, the capital appropriations requests (CARs) submitted to the main Glaxo board in respect of the K2A facility were made available.

The Vickers documentation was more directly related to the building project and generally comprised minutes of design and progress meetings, construction procurement documentation (as for Glaxo), Vickers's internal cost reports and quantity surveyor's estimates, correspondence with contractors, suppliers and consultants, and so on. The comparative absence of documented inter-office communication on the Vickers project attested to that project's fewer participants and the reliance those participants placed on informal communication. Additionally, there was very little in the nature of a documented project pre-history on the Vickers project. Access was granted to specific minutes of meetings of the main board relating to the building project. As with Glaxo, the CAR submitted to the main board in respect of the building project was made available.

Other non project-specific internal documents were reviewed relating to both organisations' investment approval procedures, technical regulations, business performance and structure.

4.6 METHOD OF REPORTING

During fieldwork, the practice of returning the author's interview notes to informants for confirmation and to help avoid misrepresentation was followed throughout. The main informants in each firm also agreed to read a draft of the case study report and to offer comment (Schatzman and Strauss, 1973). Towards the end of 1992 and early in 1993 these drafts were ready for Glaxo and Vickers respectively and were sent to the informants. Informants in respect of each case declared themselves satisfied with the accounts presented and requested only a small number of minor modifications. Following the incorporation of these modifications and further editing, the final drafts were again sent to the informants for comment. In both cases these were returned with further minor modifications and drafting suggestions which have been incorporated in the versions presented in chapters 5 and 6 below.

The case studies presented in the following chapters are both detailed and complicated. They report a great deal of technical, personal and organisational information. The view is taken that it is this very complexity which is of value to the present study. In the tradition of Bower (1970), the cases are presented at two levels of detail[15]. First, the projects are described in so far as possible in the language of the research site. These descriptions constitute the research data. Secondly, to help the reader relate this data to the propositions raised in chapter 3 and to provide a preliminary analysis of data as it is presented, interpretations of events and actions are provided, largely in the language of Bower's model. To distinguish this interpretation within the text it is shown in italic typeface. This provides a basis by which the cases may be compared in chapter 7 in respect of the study propositions.

The investment projects reported in the cases are structured broadly in terms of the key processes of resource allocation outlined in chapter 3: definition, impetus and implementation. Within this structure, material is presented generally in a chronological sequence. However, the projects described are substantially different from one another and an identical structure for each is inappropriate. As the Vickers case study follows the Glaxo study in the order of presentation here, the opportunity is taken to compare aspects of the interpretation with that presented in the Glaxo case. However, the main inter-case comparison is presented in chapter 7.

Finally, at the request of the host firms, the names of individuals involved in each case study - including the external contractors, suppliers and consultants - have been changed in the accounts which follow. The exceptions are the chief executives/chairmen of each host firm who are publicly known.

4.7 FOOTNOTES

1 Mitchell provides a critical, historical perspective on the case study tradition in social science (1983, pp188-190).

2 The fieldwork for this research was carried out between 1990 and 1992 during which time the author was an associate in a large nationally-based construction consultancy. No projects on which the author's organisation were engaged were available as case studies. Initial approaches made in respect of projects on which competitor consultants were employed indicated that access for direct, real-time observation in the tradition of Bower (1970), King (1975), and Marsh *et al* (1988) would not be granted because of the author's position in a rival consultancy.

3 See for example, Dunkerley (1988) who provides an overview of historical methods in organisation analysis together with an account of a study using case study methods, document analysis and oral histories.

4 Hammersley and Atkinson note that while the study of non-literate cultures - with an emphasis on oral history techniques - has been the main focus of social anthropology, with more literate cultures it is possible to draw on a variety of written accounts which are of considerable value to the participant observer (1983, pp127-9).

5 The discussion in chapter 5 below of the origins of the K2A investment project provide an illustration of the difficulty in locating project origins.

6 Mitchell argues that the essential point about inferences from case material is that they are based on the validity of the analysis and cogency of the reasoning rather than on claims to representivity (1983; pp190, 197-200, 207).

7 Yin (1984), p39, 48-9.

8 Access was negotiated between May and December 1990. During that period, considerable mass media interest in the operation of a number of large UK firms was generated by, inter alia, reports of insider dealing in Guinness; the sale of Rover to British Aerospace (see Economist, 1989a) and Ferranti's acquisition history (see Economist, 1989), for example.

9 Hakim (1987), p64.

10 The Times 1000 ranks firms in order of annual turnover and, while some authors have considered large firms with reference to the top 100 (for example, Channon, 1973; Prais, 1976; Hannah and Kay, 1977; Hannah, 1983), others have looked outside of the top 100, for example, Nyman and Silberston (1978; top 250), Pike (1983; top 208), Grant Jamine and Toker (1986; top 304). Any such cut-off is essentially arbitrary; there is little difference in turnover

between the 100th and 101st ranked firms, for example. When selection criteria were identified, the 10th and 100th ranked firms in the (1988) Times 1000 were separated by a factor of some 6:1, whereas a factor of 2.4:1 separated the 100th and 200th ranked firms.

11 See, for example, Hill (1988).

12 Bower (1970), pp18-9.

13 In many standard construction contracts, the issue of the certificate of practical completion has considerable contractual significance. However, it does not signal the end of construction work on site; rather it represents the issuer's opinion that the works are complete (Turner, 1983, p65).

14 Crompton and Jones (1988), p72. See also Fielding and Fielding who argue that whatever the divisions between quantitative and qualitative research:

> "..ultimately all methods of data collection are analyzed 'qualitatively', in so far as the act of analysis is an interpretation and therefore, of necessity, a selective rendering, of the 'sense' of the available data." (1986, p12.)

15 See Bower's introduction to case study material, (1970, pp83-4).

CHAPTER 5: GLAXO, CAOS AND THE K2A BUILDING

5.1 INTRODUCTION AND OVERVIEW

This case study is about the role of Glaxo in the decision and implementation stages of a capital investment project involving the construction of a factory extension (K2A) to an existing manufacturing facility (K2 at Glaxo's Barnard Castle site). K2A was built for the manufacture of cefuroxime axetil for oral suspension (CAOS). Glaxo had been marketing the active ingredient in CAOS (cefuroxime) in tablet and injectable forms around the time when the feasibility of producing a suspension form, primarily for the paediatric market, was examined.

At that time (towards the end of 1986) however, the precise pharmaceutical formulation of the suspension form and the technology for the process of its manufacture did not exist within Glaxo. The case study covers the period between the end of 1986 and the end of 1990 (when construction work on K2A was completed and manufacturing equipment installed). It examines Glaxo's role in changes occurring during the construction process caused by changes in - *inter alia* - the product formulation, the manufacturing process and the projected market demand for the product.

A brief chronology of key activities is presented in section 5.11 below. A list of key personnel featured in this case study is presented in section 5.12.

5.2 COMPANY PROFILE

5.2.1 Introduction

Glaxo Holdings Plc is a research based group of pharmaceutical companies with international headquarters in London. In 1986 it operated in 40 countries and employed around 30,000 people[1]; by 1990 operations had been extended to 50 countries and the total workforce had grown to some 38,000 people. Although the group's R&D and manufacturing facilities and activities have become widely dispersed - in 1990 there were local manufacturing facilities in some 30 countries - UK-based R&D and production for both UK and international markets employed about 30 per cent of the worldwide workforce in 1990[2].

The group was ranked 78 in the Times 1000 in 1986-87, and 64 in 1989-90. In this period, the group was one of the world's largest and fastest growing[3] in the pharmaceuticals sector. Glaxo's largest single market is now the USA which accounted for some 40 per cent of worldwide sales in 1990.

5.2.2 Organisation and structure

The history of Glaxo is one of change prompted by advances in medical and pharmaceutical research and, particularly during the 1980s, by an increasing focus on the development and manufacture of prescription medicines. By the end of the 1970s the company was diversified across a wide range of generic drugs, chemicals, baby foods and medical equipment. However, during the 1980s and under the leadership of Sir Paul Girolami - who became chairman of Glaxo Holdings in 1985 following four years as chief executive - Glaxo began to divest itself of its baby food, veterinary medicines and medical equipment subsidiaries.

Around the time of these changes the company was becoming more geographically diversified, extending operations into Africa, the Middle East and Eastern Europe in particular. In 1986, the group was organised along the lines of the organisation chart in Figure 5.1 overleaf. Figure 5.2 outlines the organisation of the principal UK-based operations in that year. During 1989 the Group began a substantial internal re-organisation to meet the needs of increasing geographic diversification in particular. The K2A project was substantially complete by that time and was largely unaffected by the re-organisation. It is worth noting however, that one of the important changes was the formation of Glaxo Manufacturing Services (GMS) to consolidate responsibility for secondary manufacture of pharmaceuticals and to provide technical support for Group companies worldwide. This had previously been shared between a number of Group companies, including Glaxo Production and Engineering Services and the secondary manufacturing and production functions of Glaxo Pharmaceuticals and Glaxo Export Ltd.

Figure 5.1 Glaxo Group 1986

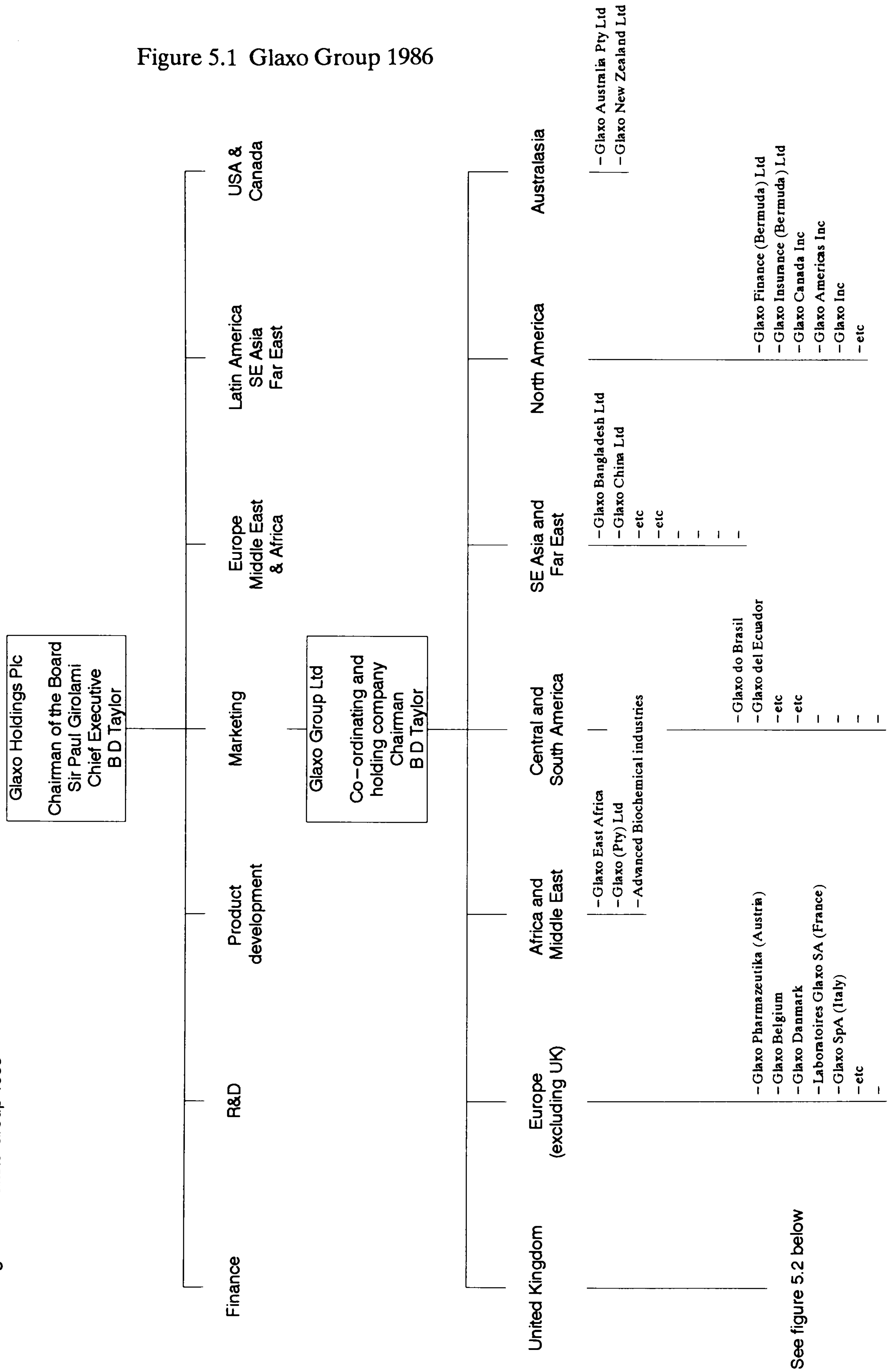
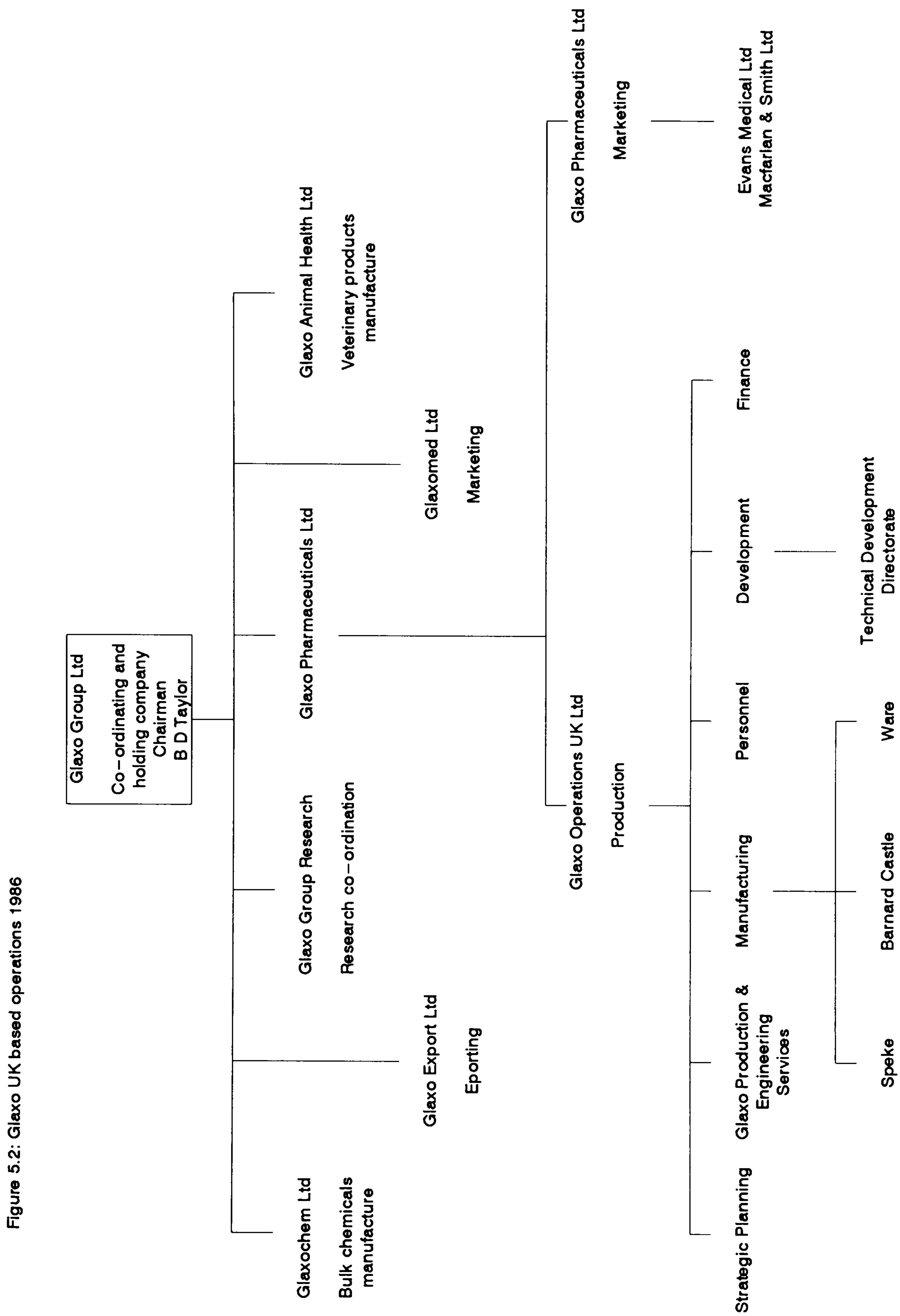


Figure 5.1: Glaxo Group 1986

Figure 5.2 Glaxo UK-based operations 1986



5.2.3 Recent market developments

Glaxo experienced considerable growth in the volume of its pharmaceuticals business throughout the 1980s. The company was ranked 21st largest pharmaceutical company in the world in 1979, and 2nd largest in 1988. In 1980, total Group sales and capital expenditure amounted to £618 million and £31 million respectively; by 1990 these were £2,570 million and £340 million[4].

This growth has been accompanied by increasing concentration of Group activities on prescription medicines. By 1990, almost 90 per cent of Group sales were concentrated on pharmaceutical products in three therapeutic areas: anti-ulcerants, compounds for respiratory disorders and systemic antibiotics. The drug ranitidine - trade name Zantac - accounts for almost all Group sales in the anti-ulcerant area and has, since 1989, become the world's largest selling prescription medicine[5].

5.3 CAOS: BACKGROUND AND STRATEGY

5.3.1 Background and origins

Glaxo's early involvement in large scale penicillin production[6] has helped give the company a leading position in the manufacture of antibiotics. The company launched its oral cephalosporin (antibiotic) cefuroxime axetil (trade name Zinnat in the UK), a tablet form of the injectable drug cefuroxime, in 1988. In its first full year - 1989 - sales in all markets accounted for some £100 million, equivalent to about 25 per cent of all Group sales in the systemic antibiotic area[7].

Prior to this launch, work had been progressing within Glaxo Group Research (GGR) on a suspension form of cefuroxime axetil for children, who dislike taking tablets. Clive Cannon, a Glaxo pharmacologist (and Development Planner on the CAOS project - see below), explained:

> "The drug actually tastes very unpleasant, so when we looked at the oral suspension development of it, the pharmaceutical strategy was to taste mask the drug in order to render it palatable."[8]

Glaxo's main competitors in cephalosporins all had suspension forms of their leading oral products: Smithkline Beecham had Augmentin and Eli Lilly had Ceclor. Furthermore, patent protection on Ceclor in the USA was due to expire in 1991. Glaxo Inc's (USA) marketing division had requested a suspension form of cefuroxime axetil. It was felt that by launching cefuroxime axetil for oral suspension (CAOS), sales of cefuroxime axetil could be increased by some 10 per cent to 20 per cent[9] . Glaxo Inc hoped that CAOS would also, if timed appropriately, capture market share before 'generic' manufacturers began to produce low cost Ceclor following patent expiry in 1991. (For a brief note on the pharmaceutical industry, see Appendix C.)

Note that the business planning context (see 4.3.3 above) was concerned with the development of new marketable products in given therapeutic areas. Note also that only a very small number of research projects ever make it to full production (see Appendix C). The 'taste-mask' version of cefuroxime was therefore about to be developed within a planning context which had been supportive of earlier forms of the same product.

At that time GGR was responsible for the identification and development of new products. Although the origins of CAOS may be traced at least to the 'discovery' of cefuroxime within GGR, whether market demand for CAOS was identified first or whether a research/development 'breakthrough' provided a marketing opportunity is not clear. As Cannon explained:

> "I think it may have been the people in the department in pharmacy division [GGR] who said 'I think we can make a taste-mask version of this product'. They may well have done some initial work before there was any decision at a senior level to go ahead. But there was a perceived need for a paediatric version of this drug because the tablets for adults were expected to be very successful."[10]

This case concentrates on the development of CAOS, rather than its discovery. The development of pharmaceutical products involves the identification and development of a manufacturing process, its transfer from the research laboratory to the production site and the scale-up of this process to the full production level. Prior to sale, the product must undergo testing for licensing and registration with the appropriate regulatory bodies in the markets in which it is to be sold. During this time or before, consideration will be given to anticipated market demand (for example, how much, where, at what price and when) and the location and procurement of the necessary capacity for production, packaging and distribution to appropriate markets.

5.3.2 Strategy

The discovery, development, licensing and registration of new drugs takes between 10 and 12 years on average. Part of Glaxo's competitive advantage is to bring products to market quickly (see Appendix C). Tony Spackman (Glaxo Pharmaceuticals technologist - see below), explained:

> "What in effect happens is that in order to have a compressed timescale of, say, 7 years, a lot of things go on in parallel. Industry averages seem to be about ten or eleven. We tend to do it in seven or eight. If you wait three or four years to get it right, you've missed it. Putting in manpower to sort out the problems is a small cost relative to the revenue lost for not getting on the market."[11]

With CAOS, GGR were developing a new form of an existing product, and therefore hoped to utilise a good deal of the effort already expended in the testing, licensing and registration of cefuroxime. The intention was to demonstrate 'bio-equivalence' between the new suspension and the tablet which had already been registered in major markets. Cannon explained:

> "...in other words if you took 250mg of the suspension it would produce the same blood levels as a 250mg tablet. Had we been able to do that, we would have been able to rely on all of the clinical data... we had already gone through that process with the tablet."[12]

This strategy required an overlap of process development and product registration, both of which are closely interrelated (see Appendix C). As will be seen, uncertainties over the production process delayed the production of documentation and CAOS samples for registration causing anticipated launch dates in major markets to be revised.

5.4 EARLY DEVELOPMENTS

5.4.1 Introduction and overview

Between examining the feasibility of producing CAOS, and identifying the need for a factory to produce it (K2A, which is the focus of this case), a good deal of decision making took place. It is important to describe some of this activity for it contains the origins of the 'discrepancy' leading to the definition of K2A which, as will be seen, were located deep within the organisation. Secondly, discussion of these early decisions introduces some of the individuals and groups involved, and establishes the procedural and organisational context within which they operated. Thirdly, it introduces a number of key themes concerning uncertainty about market demand and process technology which dominate the process of facility definition in particular.

The organisational structure for the administration of the project - including Glaxo's eventual role in the construction process - was established quickly as a matter of some routine. As will be seen, the early stages of this investment project were dominated by questions of where to locate production. Although not the subject of the present study, the process by which this appears to have been resolved - with different Glaxo Group companies effectively competing for the investment project - appears somewhat removed from the notion of rational choice based on full information (see chapter 2), and also helps set the scene for what follows.

5.4.2 The formation of the Project Task Group (Dec. 1986)

The feasibility studies for the production of CAOS, carried out within Glaxo Group Research (GGR) Pharmacy Division during 1986, identified two key processes. The primary process involved coating individual active drug particles with wax as a taste-mask. The secondary process involved blending the coated particles with powdered sugar and flavouring. This blended mixture is then granulated and dried to produce a powdery granule which gives a flavoured suspension on re-constitution with water.

At that time, John Parker was director of GGR's Pharmacy division and was, as will be seen, particularly interested in this product. One of the first formal steps in new product development was the formation of a Project Task Group to oversee the development process. This would normally involve those companies which would be responsible for production and would also contain representatives from departments responsible for 'front-end' activities such as process development and registration. On 11 December 1986, Parker announced to colleagues that "we are close to having a product"[13] and set about forming a Project Task Group.

Although responsibilities had not been defined, Parker contacted colleagues in Glaxochem, who would probably be responsible for primary production; Glaxo Pharmaceuticals, who would be responsible for secondary production if this was to be located in the UK; and Glaxo Inc (USA), who had been instrumental in identifying the product's market potential, and who were also keen to manufacture the product for sale in the USA.

Task Group membership is shown in Figure 5.3a below. The first meeting on 23 December 1986 is significant in that the need for new facilities was identified. Underwood, the Glaxo Pharmaceuticals Technical Development Division (TDD) representative, noted that if production was to be located in the UK (at Glaxo Operations Barnard Castle site), new facilities would have to be built and equipped. Samuelson (representing Glaxo Inc) indicated that Glaxo Inc were contemplating building dedicated facilities in the USA. Preliminary market forecasts presented at the meeting indicated that 5 tonnes of coated active drug would be required in the first year of launch rising to 45 tonnes by the 3rd year. "For a good product", the meeting minutes note, "the year 3 forecasts could be doubled"[14]. The meeting also considered the question of how the product was to be packaged[15] - an issue which was to prove problematic later in the project - and indicated a preference for high density polyethylene (HDPE) bottles.

The need for a new facility has been identified by Underwood, a 'facility-oriented' manager, in terms of a discrepancy between available capacity and that likely to be required. Note also Glaxo Inc's desire to *be considered as a candidate production site which, as will be seen, develops into a 'bid' for 'ownership' of production for their own market. However, there was uncertainty over the market forecasts (for the USA only and subject to a wide error margin) and over pack options, and there was no mention at this stage of an overall timescale.*

5.4.3 Progress with facility definition (Jan. 1987)

In January 1987 Parker instructed Underwood to examine the definition of a facility for CAOS production. Underwood presented details of the production facility at the next meeting of the Task Group on 9 February 1987. His written report provides the first formal definition of both the process and the production facilities. Underwood's report notes:

> "Because of the uncertainty in process detail we have designed a building based upon a portal frame structure, in which there would be no internal columns. ...we have derived a facilities design which requires a building shell of approximately 60 metres by 40, with an internal height of not less than 11 metres."[16]

Construction facilities were estimated to cost between £12.9m and £13.4m, depending on the infrastructure provision at the chosen site. The meeting minutes note that the facility could be built in either the UK or the USA and that:

> "the major decision rests on which site could complete the facility the fastest".[17]

Rapid progress had been made by Underwood throughout January in the definition of a new facility in terms of size and cost. The extent of this appears surprising, given uncertainties over market demand (no new forecasts of market demand had been provided since the December meeting), process and packs. However, it would appear that Glaxo Pharmaceuticals (as well as Glaxo Inc) were keen to be involved in the manufacture of this product, and this may help explain Underwood's detailed and, as will be seen, somewhat premature facility definition. It is worthwile noting that at this point, no mention of 'aggregate financial' considerations such as return on investment had been made in Task Group meetings.

Figure 5.3a: The CAOS/K2A project structure

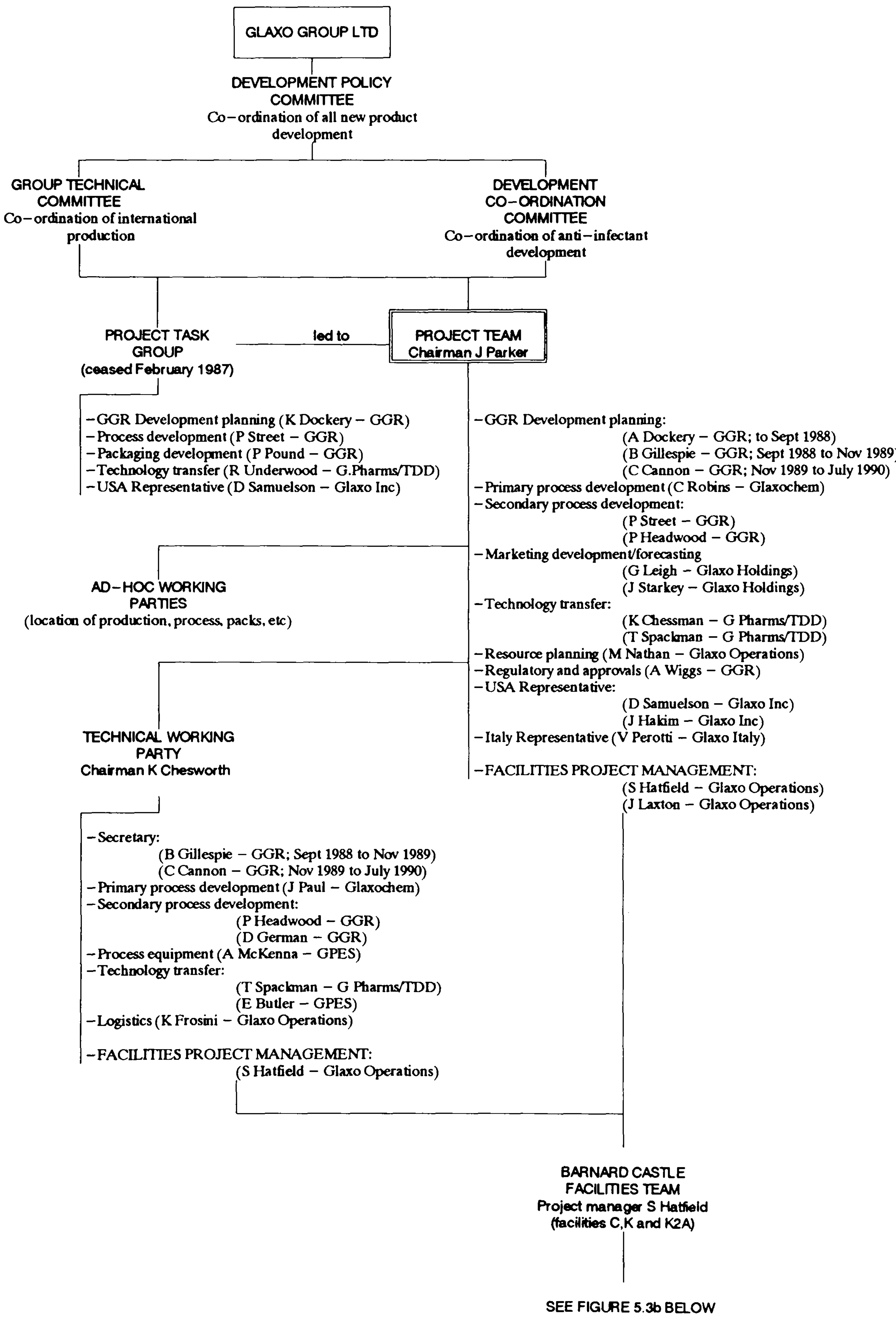
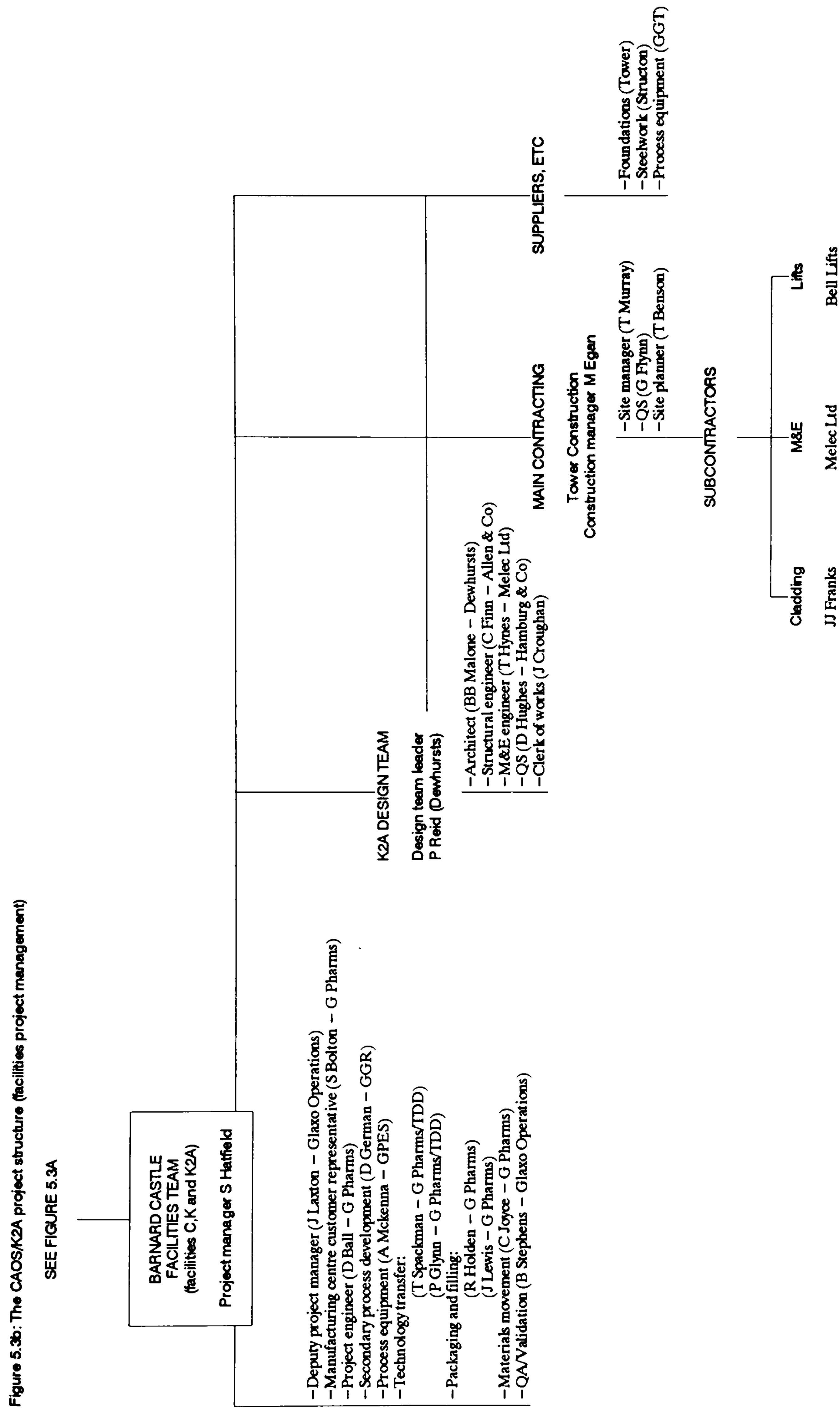


Figure 5.3b: The CAOS/K2A project structure (facilities project management)



5.4.4 The formation of the Project Team (Feb. 1987)

The next meeting of the Task Group was as the Project Team on 25 February. Project Teams were an established part of product development. They dealt with one product and reported directly to the Development Co-ordination Committee (DCC), which dealt with all development projects in a particular therapeutic area. DCCs in turn reported to the Development Policy Committee (DPC) which had overall responsibility for all development activity worldwide. (Note that these committees provided a research co-ordination function and had little or no say in the financial approval of investment projects - see below, section 5.6.8.) The core of the CAOS/K2A project structure was now established. The overall project structure is outlined in Figures 5.3a and 5.3b together with the function and membership of the various teams and committees.

Project Teams had overall responsibility for bringing products out of research and into the market. This process inevitably involved detailed operational matters concerning technology transfer and the acquisition of appropriate productive capacity (buildings, equipment and personnel). Thus as projects progressed, these detailed matters became the day-to-day responsibility of other, lower level teams concerned with the specifics of large scale production (see Figure 5.3a). Stewart Hatfield (a Glaxo Operations project manager) distinguished between the Project Team's "strategic planning and development role" and the more "tactical and logistical" role of these lower level teams[18].

The CAOS Project Team was initially responsible for co-ordinating a number of diverse activities including the development of the production process, product licensing and registration in all major markets, the forecasting of market demand, the transfer of process technology from GGR to the manufacturing site, and the planning and acquisition of appropriate capacity. The Project Team met monthly (on average) and its membership changed substantially over time as the project progressed - altogether, some 52 different Glaxo personnel attended formal Project Team meetings throughout its life. Its 'core' membership was as shown in Figure 5.3a. Cannon (who co-ordinated the CAOS Project Team after November 1989) noted that it was "relatively unusual" for John Parker, as director of GGR Pharmacy Division, to chair the Project Team. As Cannon explained:

> "The Project Team chairman would not usually be so senior a person. John Parker was particularly interested in this project."[19]

5.4.5 Discussions about the location of production (Feb. to May 1987)

Prior to the first formal Project Team meeting on 25 February, the question of the location of production appeared to be resolved. Parker wrote to team members as follows:

> "It was decided at this week's GTC [Group Technical Committee] that Glaxo Inc should be invited to put forward their plans for secondary production of this product in its totality. The Ulverston [Glaxochem's UK plant] option is still on the table but, because of the need for rapid approval of the proposal, work on a Zebulon [Glaxo Inc's facility in the USA] plan will proceed"[20].

The need for 'rapid approval' was due to USA requirements to establish a market before the expiry of the Ceclor patent (see 5.3.1 above). Glaxo Inc had estimated that this would require a launch by the 3rd quarter 1988. The approach, then, was for GGR and Glaxochem to develop both primary and secondary production processes for eventual scale-up and transfer to Glaxo Inc's facility at Zebulon. The secondary process scale-up was likely to involve Glaxo Pharmaceuticals and their operations division (Glaxo Operations) at Barnard Castle. Barnard Castle was therefore represented at Project Team meetings by Hatfield, a project manager who replaced Underwood from 25 February 1987.

By the Project Team meeting on 15 May there were indications that Glaxo Inc's facility would not be ready in time for product launch in the 3rd quarter 1988. The meeting minutes note that:

> "If Zebulon is not ready to granulate and fill for launch, alternative contract facilities will have to found in the US, as there are currently no Glaxo facilities in the UK."[21]

Although Glaxochem had agreed to build a pilot plant at Ulverston for primary production and to develop the process for eventual transfer to Zebulon, this would not have the capacity for full production. These matters were beginning to concern Parker, and he called an ad-hoc meeting of the Project Team specifically to help resolve the issue of where production was to be located. This was attended by representatives from GGR, Glaxochem, Glaxo Pharmaceuticals, Glaxo Inc and Glaxo Holdings. The minutes note that Parker, chairing the meeting, opened by stating that:

> "At the last GTC, it was considered unrealistic to expect Glaxo Inc to build a facility for all the processes in the timescale required for this product"[22]

and went on the say that the GTC - which Parker attended - had 'selected' Ulverston for primary process development and pilot production and Glaxo Pharmaceuticals' Barnard Castle site for (secondary) granulation and filling of initial commercial stocks. Although Hakim, representing Glaxo Inc, stressed the commercial importance of the product to Glaxo Inc and their need to have the capacity to support market demand, the discussion concentrated on available facilities at Barnard Castle. Development of temporary facilities there would enable an early launch independently of the pace of development of the main production facility at Zebulon. It was acknowledged at the meeting, however, that Barnard Castle could also have a long term role in serving the UK and other European markets.

5.4.6 Increasing focus on Barnard Castle (Jun. 1987)

As process development work continued, the extent to which existing Barnard Castle facilities would require modification for CAOS production was becoming clearer. Hatfield raised his concern to Clive Chandler (Glaxo Pharmaceuticals' managing director) following the 17 June meeting:

> "Following this week's meeting...it is now clear that providing cover for Glaxo Inc. has become a pressing need... I shall be reviewing our options in C block and K2 next week with Production and Development colleagues. Thereafter I shall involve site (C) and GP&ES [Glaxo Production and Engineering Services] Engineering."

Additionally, Hatfield was also concerned about Barnard Castle's more long term role in serving the UK and European markets. He continued:

> "The need to support Glaxo Inc quickly must be balanced against the potential long term need to supply the UK and other markets. This may dictate a two phase project. I suggest that we meet in a few days' time to review the position."[23]

Chandler wrote to John Murray (the site factory manager at Barnard Castle, who would ultimately be responsible for CAOS production) to confirm his understanding of the outcome of the 17 June meeting and the subsequent GTC meeting which "endorsed this strategy with approval". This meant, *inter alia*, that secondary process development would be undertaken at Glaxo Pharmaceuticals' facility in Barnard Castle following which secondary production would be located at Barnard Castle and Zebulon, and that:

> "...the small but significant filling capacity to be installed at Barnard Castle would also have to be used for the manufacture of USA launch stocks. Following review with Stewart Hatfield, my understanding is that a proposal will be submitted shortly ...".[24]

The period since April 1987 is a critical period in the clarification of production intentions and in the definition of facilities. Note that until early June, the definition of facilities had not progressed at all since Underwood's proposal of January. In fact, that definition is now irrelevant. The location of production has been the main focus of attention. (Although access was not granted to GTC meetings or minutes, it is clear that there was considerable competition between Glaxo Inc and Glaxo Pharmaceuticals for the location of production.)

Revised arrangements for the production of launch stocks have forced Hatfield - a 'facility oriented' (project) manager - to think about the implications for Barnard Castle. He enlists more senior help (Chandler) to help clarify both the GTC intentions for the location of production. His job allows him to raise the more strategic issue of the possible long term role for Barnard Castle in CAOS production. Note also the impetus provided by Chandler in his indication that "a proposal" in respect of Barnard Castle facilities was expected.

5.4.7 Revisions to the launch schedule and the market forecasts (Jun. to Sept. 1987)

During the summer months of 1987, process development work continued at Ulverston and Barnard Castle. The results of bio-equivalence studies became available in early July. This represented a considerable setback as the tablet and suspension were not bio-equivalent on all parameters. The immediate implication was that the Food and Drug Administration (FDA) in the USA would require an extensive programme of time-consuming clinical trials resulting in delays in the submission of the New Drug Application (NDA - see Appendix C) and subsequent product launch.

Around this time Glaxo Holdings Marketing Division were beginning to generate market requirement data in respect of most major markets - previous market forecasts had been provided by Glaxo Inc. in respect of US demand only. Feedback from individual markets indicated changes in pack requirements, in particular that some markets (notably France and Italy) now required glass bottles instead of plastic. Market forecasts of drug quantities were being refined, but - like the earlier Glaxo Inc forecasts - they continued to be expressed in terms of tonnes of primary product per annum. While this was of use to Glaxochem - who felt able to cope with projected demand of wax coated material - it made less sense in terms of secondary production and final product. Hatfield (who was now beginning to involve colleagues on materials movement and packaging issues at Barnard Castle - Lewis and Holden; see Figure 5.3b) wrote to Murray on this latter issue in August 1987:

> "We have market forecasts for the product, but only total drug requirements, not by bottle size - which is essential. I have stressed this need to Marketing. Exactly which markets will be served from the UK, and whether they will take wax coated granule, bulk product or filled product is not clear. My instructions from marketing are to assume the worst production case for capacity planning until advised otherwise, ie Barnard Castle will make all launch stocks."

Hatfield confirmed that current intentions were to use existing facilities in K2 block for production; the existing filling line in K1 would be modified. Process development was underway using C block equipment, but the intention was to convert this to other production on completion. However, he was becoming concerned at the prospect of compiling an investment proposal for submission to the Glaxo Board, given not only the uncertainty about market demand but also about packs and the secondary production (granulation) process. He concluded:

> "You will appreciate from the above that we do not have much to go on. However, it is not as bad as it seems. There is confidence in GGR that the granulation process will prove straightforward. The key decisions needed are the bottles to be used and the market demand by bottle size.... Only after this, and more process details from GGR, can we submit a proposal".[25]

Hatfield's demand for better market data by pack size was noted by Murray and by the Project Team. By the end of September, John Starkey of Marketing Division had written to Glaxo companies worldwide to request their anticipated registration and launch dates and to ask for forecasts of demand by preferred pack size for the first 3 years following launch.

The project had now become considerably more complex than had been envisaged when Parker formed the first task group. Confirmation that bio-equivalence had not been established meant a tougher, lengthier and costlier registration process with consequential delays to the launch in the USA in particular; new market information indicated uncertainties over the range of pack types and sizes; problems with the production process had not yet been resolved; and there were still no hard data on the likely volumes of secondary product which would be required. In this context the facility definition tabled by Underwood in January appears particularly premature. Note also that it is Glaxo companies in the individual markets who are providing market information - a particular problem facing this large geographically diversified firm was the management and co-ordination of this activity.

5.5 K2A: THE PROCESS OF DEFINITION

5.5.1 Introduction and overview

The emergence of CAOS from the UK-based GGR, and the close involvement of Glaxo Pharmaceuticals personnel in process development and production planning appears to have contributed to the increasing focus on Barnard Castle as a production site. Although the intention was for Barnard Castle to manufacture initial stocks only, it eventually became the main CAOS production site. This section outlines the origins and process of the K2A facility definition and examines changes caused by, *inter alia*, changes to forecasts of market demand. Particular attention is paid to management of the definition process which is the subject of propositions A, B, C and D (in section 3.4.2 above).

5.5.2 Identification of the need for K2A (Sept. to Dec. 1987)

Throughout the summer of 1987, Hatfield had been involving more personnel from Glaxo Pharmaceuticals and from GP&ES to examine production implications in detail. In September it was confirmed that Glaxo Inc would not construct a new facility at Zebulon in time for the USA launch. Hatfield then formed a site-based project team with colleagues from production and packaging to consider the implications of (GGR) Project Team meetings for Barnard Castle facilities. Formal meetings commenced in September 1987 (see Figure 5.3b).

The last three months of 1987 was a time of increased activity for those involved in the CAOS project. Mike Nathan of Glaxo Operations Strategic Planning Unit (SPU) had now joined the Project Team, attending his first meeting on 19 October. He defined his role during October 1987 as follows:

> "My job then was resource planning manager for Glaxo Operations UK and I was responsible for planning demand and capacity for the UK factories on a 0 to 5 year 'time horizon'."[26]

The returns from Starkey's survey of international markets indicated that a number of markets wished to take (unfilled) bulk secondary granule and to fill locally. This would increase pressure on secondary manufacturing rather than filling capacity. Nathan and his colleagues at Barnard Castle began to think that, although 7 day continuous shift operation might meet market forecasts after about two years in production, available capacity in K block would be exhausted shortly thereafter. The first indications that there may be a capacity problem in the existing facilities at Barnard Castle were beginning to emerge (see the CAOS Forecasts graph, Appendix D.3). Additionally, the survey indicated that, despite previous attempts by the Project Team to standardise on plastic bottles, there was now a clear requirement for glass bottles, accounting for some 55 per cent of worldwide demand.

Hatfield held a meeting on 20 November with Barnard Castle colleagues to discuss the implications of these developments for production in K2 block. He wrote to Murray that day to summarise the position and concluded:

> "Forecasts indicate that double shift capacity will be exceeded in year 2 in both manufacturing and filling. This assumes that Barnard Castle is the sole supplier, and that the pronounced seasonal peaks are smoothed. Continuous shift working (5 or 7 day) will provide about another year's cover. Much depends on sourcing decisions, forecast revisions, the introduction of USA facilities, etc. However, this is a key area and conceptual plans are being developed for additional capacity. These comprise a further building extension for manufacture and an extra line and/or a modified line in 'K1' for filling."[27]

The cost of the extension to K (which would become known as K2A) block was put in the region of £3m-£4m by Hatfield as "my best estimate". The Barnard Castle team were now considering the production implications for their site in some detail, including equipment, materials handling, services and personnel accommodation. Hatfield suggested that the site team have another meeting to consider their requirements - both in respect of K block modifications and any extension which might be needed before involving outside design consultants:

> "In K2A the architects were involved very early, at concept stage. The architects were presented with: 'We've got this process, we want a building to accommodate it' rather than a pre-developed concept, which is more usual. This was because of the need to get the product into production quickly."[28]

The increasing focus on Barnard Castle combined with upward revisions in the market forecasts and a clearer indication of what these meant in production and capacity terms had led Hatfield and his colleagues - all concerned with facility and capacity planning - to identify the need for a *new facility (K2A). Note that they defined the facility in capacity and capital cost terms; the information available to them was considerably more detailed than what was available to Underwood some 10 Months before, but their definition was more tentative. Although as will be seen, the development of CAOS involved a number of production 'projects', from now on the focus for this case is increasingly the K2A construction project.*

The forecast increase in market demand and the changes in pack requirements arising from the market survey led to an ad-hoc meeting of the Project Team on 27 November to discuss packs and secondary production issues. The meeting considered the implications of increased market demand and supported Hatfield's proposal (of 20 November) for additional facilities, noting that secondary production at Barnard Castle "will need considerable investment to provide the forecasted offtakes world-wide"[29]. One week later, at the Project Team meeting on 4 December, the possibility of investing in an extension to K block received further support:

> "Barnard Castle will have to support launch and initial production for all markets other than Japan (1991 launch) and those markets supplied from Italy. Current capacity is inadequate and considerable investment will be required."[30]

Agreement at project team meetings that considerable investment is required may be viewed as a form of impetus very early in the definition process. The definition process was now dividing in two - the activities at the production site (K, C, and a possible extension to K2) where Glaxo Operations/Pharmaceuticals personnel were primarily concerned with facility definition and the 'operational' detail of getting the product to market; and the activities of the Project Team, where the 'project' continued to be defined in its widest terms - primary and secondary process development, location of production, filling and packs, market forecasts, clinical trials and registration, alternative formulations, and so on. However, largely because of uncertainties over launch dates and volumes in major markets, there would appear to have been no central timetable for the planning and co-ordination of these different activities associated with definition.

5.5.3 Early definition (Dec. 1987 to Jan. 1988)

The Project Team continued to meet monthly and, in a measure of how complex the project had become, continued to convene separate meetings on specific issues such as primary process problems and process development and manufacturing.

Nathan and his colleagues had estimated that between 400 and 500 tonnes of secondary product would need to be produced annually after 1990/91 (see the Forecasts graph, Appendix D.3), with a peak demand of 800 to 900 tonnes. Steve Bolton, a production manager (from the Cephalosporins Manufacturing Centre - CMC - who would eventually operate K2A) was assisting Nathan in the preparation of capacity estimates. He wrote to Hatfield just before Christmas, 1987, pointing out that the capacity of existing plant (70 to 120 tonnes per annum - tpa) was considerably below these figures, noting:

> "To cover a 500 tonne demand my previous suggestion of a 500kg batch would be inadequate. 'Standard' fluid bed dryers are available up to 2000kg capacity, however we have no feel for this process at that size, in fact little feel for it at 200kg. These figures are so large that the present equipment is instantly outstripped on capacity."[31]

Hatfield felt that these latest demand forecasts confirmed the need for capital investment he had identified in November. He wrote to Murray following his return from holiday in January 1988:

> "The latest demand estimates ex M. Nathan present a very different and challenging situation for Barnard Castle. K2 can no longer support the product launch. The first year forecasts are now about twice the 5 day/3 shift capacity. I will be brainstorming methods of meeting this challenge with colleagues later today. My initial reaction is that the Board must now accept that a major project is required... Finally, we don't have a process yet!"[32]

5.5.4 Alternatives identified and rejected (Jan. 1988)

In a subsequent memo to Murray, Hatfield suggested that C block could be used for production following the completion of granulation trials which were currently underway, which would:

> "...buy us about one year of major project time, leaving about two years to do something permanently. For a permanent facility the latest forecasts suggest an increase in batch size from 200kg to 1000kg. We have no experience of this scale of operation in terms of raw material, bottle and finished pack movements.... A further extension [to K block] or a separate building is indicated. There has not been sufficient time to develop a budget, but I believe that the £3m ±50 per cent in the capital budget is now inadequate."[33]

The next day Hatfield wrote again to Murray, outlining a number of options available to meet this demand from Barnard Castle. That day, Murray wrote to Chandler with an (almost verbatim) account of all the points in Hatfield's memos of 4,5 and 6 January. Murray summarised the options available as:

1. Install larger capacity plant in K2: £2m-£3m;
2. Extend K block: £4m-£6m;
3. Provide new 'portal frame' building: £6m-£9m;
4. Use K block storage for CAOS production: unknown cost but expected to be similar to 2;

and concluded that options 1 and 2 were preferred.

This is a critical period in both the definition and impetus phases for K2A - note that the discrepancy between available and required capacity appeared unmistakable, and that Hatfield had clarified the facility definition in both capacity <u>*and*</u> *cost terms. Further, the market forecasts indicated a substantial demand in 1990; Hatfield felt that approval of funding for a major project would be required urgently if the building was to be designed, built, commissioned, validated and in production in time. He had identified alternative approaches to meeting the forecast demand, all of which required substantial capital investment and had therefore pushed Murray to consider the likelihood of capital investment in a 'major project'. Murray lent support to the project without affecting Hatfield's definition by saying much the same to Chandler, the effect of which was to give the project further impetus.*

Hatfield and his Barnard Castle colleagues met on 22 January to consider the options available and rejected all but option 2 (in 5.4.2 above). Peter Reid, an architect and partner in Dewhursts (consultant architects) was present and was asked to begin preparing floor plans for the K block extension - now called K2A. Hatfield wrote to Murray shortly afterwards summarising the outcome of the meeting:

> "We have discounted a new building (unnecessary), the 'shoe horn' approach (impossible) and the re-use of K block storage (expensive/impracticable). Thus, we are left with an extension ('K2A') on 'K2'. A more detailed, but nonetheless rough, cost estimate confirms our original order of cost of £4-6m... But I would reserve judgement on changing the estimate until we have an outline conceptual 'K2A' design to cost."[34]

He noted that there was time to construct a building extension before the peak demand period (3Q 1990), but that GGR continued to experience difficulty with process development. Hatfield's memo was again sent by Murray to Chandler the next day with a covering note:

> "I propose that we continue to develop a design for a K2 extension in order that we are able to provide manufacturing capacity in the shortest time possible. This, of course, assumes that a project for this product in the £4-6m range has a reasonable chance of authorisation."[35]

Nathan had also written to Chandler the previous day, 26 January. He considered that there were "two major risk areas" associated with the proposed K2A facility. The first concerned the FDA's recent refusal to approve the tablet form for treatment in two important therapeutic areas; both tablet and suspension might consequently have a lower demand potential. The second concerned uncertainties surrounding the production process. He concluded:

> "Against the present demand scenario, it is recommended that Glaxo Pharmaceuticals install spray granulation capacity of 500tpa... The cost of this facility will be £4m-£6m and could be completed in 2-2.5 years from project approval. The demand and technical risks presently associated with this project, however, indicate that work is progressed only to the point where the final process and capacity requirement can be defined."[36]

Hatfield confirmed the time required to construct the new K2A extension in subsequent correspondence with Chandler:

> "It is possible to build an extension on 'K2' before existing capacity is exceeded. This would need to be fast-track through authorisation/design/construction."[37]

Murray's continuing support of Hatfield's proposal and his 'innocent' enquiry of Chandler helped generate further impetus (both men, after all, are in the formal authorisation chain - see below). Nathan's recommendation to Chandler was more of an 'independent' confirmation of what (the more partial) Hatfield and Murray were proposing, and consequently was of considerable value in both defining what was needed and in providing impetus to the proposal. Hatfield's proposal for a 'fast track' approach promised to generate tangible financial commitment to the project in advance of full authorisation by the Group board.

5.5.5 Delays and revision to launch dates (Feb. to Jan. 1988)

During February and March 1988 GGR continued to have difficulties granulating the wax-coated material from Glaxochem's newly installed plant at Ulverston. Meetings of the Project Team and its ad-hoc sub groups - as well as meetings of the Barnard Castle CAOS team - were now concentrating on a greater level of detail regarding all aspects of the product and the plans for its manufacture. The issue of packs continued to be unresolved. In particular, there was uncertainty over pack sizes and the type of material required for different markets and treatment regimes, the form of pack closure, whether the pack would contain a measuring device, and the kind of light protection needed. Attempts were again made by the Project Team to standardise on pack sizes and types, and agreed that packs would not be offered in glass.

However, problems with process development were now affecting progress with facility definition. At the April Project Team meeting Hatfield noted that:

> "The conceptual design had been costed and was consistent with the rough estimate of £5m [discussed at the 20 November Barnard Castle meeting]. No further work is possible until the manufacturing process is clear."[38]

Prior to the April meeting, Parr (the Glaxo Pharmaceuticals finance director) had written to Nathan of SPU - as a matter of routine -

requesting estimates of capital expenditure for the coming 5 years. Nathan indicated that likely capital expenditure between 1989 and 1990 would include £5m in respect of K2A.

Although the 20 November meeting heard that capital investment of some £3m-£4m may be required, a budget was established by Hatfield of some £5m (including manufacturing equipment - see the K2A Cost Estimates table, Appendix D.5) and this was included in Glaxo Pharmaceuticals' five year plan of 1988/89.

During April and May, problems with the wax-coating process had now been resolved by the addition of sodium laryl sulphate (SLS) at both coating and granulation stages. However, this had - somewhat fortuitously - improved the product's re-constitution and a sachet presentation, previously thought impossible, was now feasible. The problem for the Barnard Castle personnel involved in preparing for production was that there was no sachet filling capacity available. Further filling line problems emerged with the decision by the FDA in April that a tamper-evident closure would be required.

All of these matters complicated and delayed the facility definition process, and progress was disrupted further by the FDA's announcement in April that additional clinical studies for CAOS were required. This effectively put back the date for submission of the NDA by 8 to 9 months, and meant that the USA launch would now be in 3rd quarter 1990. The GGR clinical trial programme at that time was running behind schedule[39] and launches in countries other than the USA were now planned for 3rd quarter 1989. However, by the 1 June Project Team meeting, the anticipated launch in the USA had been further revised, to 4th quarter 1990 (Rest of the World launches were also revised, to 3rd quarter 1990).

These revisions appeared to place the prospect of major capital investment in the K2A facility in some doubt. As Glaxo Inc proposed to start the first phase of the Zebulon facility by the end of June 1988, they could therefore be ready for the USA launch at the end of 1990. Further, by the end of June Nathan had received revised demand forecasts taking account of the changed launch. In a memo to Murray, Nathan outlined some of the implications of these revisions:

> "It is now expected that the US will accelerate their capital programme and have capacity available to support their own launch. Italy are expected to install capacity for their own and Group needs."[40]

Prior to this Hatfield had asked Laxton to consider the production implications for Barnard Castle if K2A were not to proceed as

> "Clive Chandler...was of the opinion that K2A was unlikely to gain support now that Italy is one of the manufacturing sites."[41]

Nathan, however, confirmed that investment in K2A was still required, and that he was planning for a capacity requirement at Barnard Castle based on 2-shift working and 60 per cent capacity utilisation[42] to provide capacity for future growth and for back-up for Italy and the USA:

> "Although judicious management of Barnard Castle's capacity could probably meet... demands through the 5 year plan period, little strategic back-up could be given. It is recommended that Barnard Castle bring forward options to meet a market demand 350tpa..."[43]

By mid-summer 1988 the earlier momentum which had forced the pace of project definition had slowed considerably. The revision to launch dates, particularly in the USA, had given all project teams some breathing space. However, it meant that other possible production sites could again be considered and raised doubts over proposals for K2A. Additionally, other uncertainties regarding packs and formulation changes were continuing to divert the Project Team's attention away from production issues.

5.5.6 Further discussions about the location of production (Jul. to Aug. 1988)

Throughout the summer Hatfield continued to press for the preparation of board papers in respect of K2A. On 8 July he wrote to Murray outlining the options available at Barnard Castle, requesting guidance on which option to progress. He indicated that, if Barnard Castle and Italy jointly were to manufacture for all markets (except the USA and Japan), the K2A extension would need a 500kg granulator (1000kg if Italy was excluded from production).

The GTC in July confirmed that facilities were required in Italy and Barnard Castle, both[44] with a capacity of 350tpa (500kg granulator). Clarke, of Glaxo Holdings, who attended the July GTC, wrote to Chandler and Perotti (Italy) about the decision to locate production in the UK and Italy:

> "...could each of you critically re-examine the GTC conclusions to determine whether they make the most sense locally."

Clarke was primarily concerned about the implications for Barnard Castle if Italy manufactured only for the Italian market. In particular, he asked whether there was

> "a different, but more sensible breakpoint in scale to consider at Barnard Castle and what is the next increment?"[45]

Both Laxton and Hatfield had been concerned that a 500kg granulator would prove inadequate should forecasts increase. Before going on holiday in August, Laxton wrote to Murray and Cargill (the Cephalosporins Manufacturing Centre manager) arguing that a 1000kg machine "provides the most flexible option" and adding that it costs only some 10 per cent more than the 500kg machine. Laxton also indicated that if Barnard Castle were to provide more than 350tpa (ie all world demand excluding the USA and Italy) then the 1000kg machine would be out of capacity on the 60 per cent rule and that this scenario

> "...would require an expansion of K2A to include two granulation towers with a total capacity of some 1000tpa... This expansion could be carried out on a phased basis."[46]

Hatfield wrote to Murray and Chandler and confirmed that the 1000kg machine was the preferred option, concluding:

> "I will initiate the preparation of a Board Paper based on our conceptual design for K2A with a 1000kg granulator."

Although the GTC had requested proposals for a 350tpa installation at Barnard Castle, Clarke's questioning of whether this was sufficient *resulted in the Barnard Castle team arguing that a larger installation was needed for the company's 'strategic' needs. Note also that the possibility of an extension to K2A (itself an extension to K2) has been identified. Clarke's intervention also helped clarify the definition of K2A.*

5.5.7 Process and pack problems (Aug. to Oct. 1988)

During August 1988 the Barnard Castle team were joined by Don Ball, a senior project engineer, and began work on the preparation of Board papers. However, Hatfield had heard informally that Glaxo Inc. might not have facilities operational in time to support their launch - capacity estimates in respect of Barnard Castle assumed that Glaxo Inc would manufacture for the USA - and he alerted colleagues to the possibility of supplying the USA for up to two years after launch.

By September, the packs problem had still not been resolved. The Project Team noted that the suspension with the new SLS formulation tended to thicken more than the old on storage, and that this might have implications for packs in terms of the material used - in particular, whether adequate protection from moisture vapour was being provided by HDPE - and the bottle neck width. The formulation was examined by GGR to determine the cause of this. A number of Project Team members were becoming concerned at the lack of progress and the delays caused by changes to the formulation and by a lack of definitive requirements for pack types and sizes. In October Parker wrote to all Project Team members in an effort to dispel growing concern in the team that these problems were adversely slowing the registration programme:

> "I want to write to you to confirm where we all stand as a team on this project. It is vitally important that we all speak with one voice if we are to achieve our planned objective of registration submissions worldwide during 1989. I feel that during the last few weeks some of you or your colleagues may have had some doubts as to our progress in meeting these objectives. Let me confirm that, as things presently stand, we are on target for our submissions. There is a great deal left to do, but I know that I can count on your support in getting there."[48]

At a meeting two weeks later (on 31 October) to discuss secondary production, GGR indicated that 38mm necked bottles in HDPE were now required for all markets.

The extent of the problem of identifying market demand needs to be clarified. The marketing division were attempting to obtain information on expected registration and launch dates, sales volumes and pack preferences in up to 30 culturally diverse markets, for a product the precise pharmaceutical form of which was unknown. The problem for those involved in facility definition was that changes in launch dates and sales volumes, as well as changes in the secondary production process, made the definition of the facility very difficult. Although attempts were being made to progress a range of development activities in parallel: facility definition, market forecasting and registration planning; all interacted with process development. There does not appear to have been a strong central timetable for this which would have helped in the management of all development activities.

5.5.8 Managing facility definition (Sept. 1988)

Planning for secondary production facilities at Barnard Castle now involved a number of parallel (and interrelated) activities. Hatfield was becoming concerned that all of these projects needed some overall management and co-ordination. He wrote to the Barnard Castle team to clarify the position:

> "K2A and all associated projects are to be co-ordinated as one task. This applies to authorisation and design particularly".[49]

He listed six 'projects' as follows:

1. The K2A manufacturing facility
2. Modifications to K2 block
3. Process development in C Block and associated modifications
4. Modifications to the existing K1 filling and packaging area
5. Additional changing/relaxation accommodation for K1 filling/ packaging personnel
6. Additional office/administration accommodation.

Projects K2, C and additional offices were independent of other projects. Projects 4 and 5 - product filling/packaging and associated accommodation - were at that time dependent on the choice of filling/packaging methods which had not been resolved, and the materials movements between K2A and K1 (see the Site and Building layout, Appendix D.1).

Laxton was now beginning to take over a number of Hatfield's duties at Barnard Castle team meetings. The 20 September meeting noted that the scheme design for K2A was to be complete by the end of December at which time a Board Paper would be submitted. It also noted that with a design and building period of some 18 months and a further validation period of 6 months, K2A would be "on stream" by the end of the 1st quarter 1991.

Recent progress has confirmed the definition of K2A centred on a 1000kg granulation plant; note, however, the increasing complexity of the context in which the definition process was taking place, relating to a number of construction projects at Barnard Castle (as well as facility definition in both the USA and Italy). In the two years since Parker formed the first Task Group with the announcement "we are close to having a product", K2A had still not been defined in the kind of detail presented by Underwood in January 1987. Note also that considerable time and effort - which included outside consultants' time - had by this time been spent on the definition of K2A (and related projects); the project was now defined in some detail in terms of size, accommodation, cost and time of availability.

5.6 K2A: DEFINITION TURNS TO IMPETUS

5.6.1 Introduction and overview

This part of the case covers a period of about five months (November 1988 to March 1989 inclusive), from when the definition of capacity requirements began to be fixed on a 1000kg machine, to the submission of the investment project as a formal capital appropriations request (called 'Development Project' - DP - in Glaxo). It examines the more formal involvement of the construction industry and the role of Glaxo management to help explore the source and nature of the 'impetus' which moved the proposal toward funding. Material presented is therefore directly relevant to a consideration of propositions A, B, C, D, E and F (in chapter 3, section 3.4.2 above).

5.6.2 The involvement of construction (Nov. 1988)

The first K2A design team meeting was held on 9 November 1988 and chaired by Reid of Dewhursts. Although Reid had been involved since January 1988, his contribution had been mainly advisory. Little design development work had been undertaken, and cost estimates provided up to this point - by quantity surveyors Hamburg & Co. - had been on the basis of broad estimates of floor area requirements provided by the Barnard Castle team. This first meeting was therefore intended to brief the designers (architects Dewhursts; structural engineers - Allen & Co., and M&E services designers - Melec Ltd) on the requirements both of the CAOS process and of the production programme.

All of these consultants had worked with Hatfield and Laxton before (on the construction of K block). Hatfield noted:

> "We like to work with a relatively short list of people because in essence they have to be trained to meet our needs."[50]

Hatfield was keen to stress the short time available to design, construct and commission K2A in time for production by late 1990. He was unable to attend the first design team meeting but wrote to Laxton beforehand:

> "My key message is that this is a 'fast track' project and that the design team leader[52], Peter [Reid] should push everyone along to achieve the earliest completion of the scheme design."[53]

At the 9 November meeting Laxton indicated that Hatfield now wished to submit a proposal to Glaxo's Main Board by the end of February. The overall construction programme was discussed and the minutes note that structural steelwork drawings would need to be complete by April 1989 and an order placed to ensure a June 1989 start on site and a July 1990 completion. Additionally, Building Regulations and planning approval would need to be applied for by 1st March 1989.

5.6.3 The 'briefing' process (Nov. 1988)

By the end of November, Bolton, who was now the Cephalosporins Manufacturing Centre 'client representative' (see Figure 5.3b), and Ball had drafted a 'design brief' for K2A which sets out, in the form of a performance-type specification, what is required of the K2A building. This was a 'customer brief' for the project manager, describing the building in terms of the capacity of the processes to be accommodated rather than of the specifics of accommodating them. Bolton recalled that the process of compiling the brief involved wide consultation within Glaxo:

> "So we ended up with a brief which basically said we were looking for a facility that would handle this amount of product on this shift pattern with so many staff. It talked about the extent of automation (we wanted a computer controlled building that was as close to computer integrated manufacture as could be) and from that we then started working in detail and coming up with designs."[54]

Hatfield outlined his role in this briefing process:

> "...there are varying degrees of activity associated with [briefing], from customers who are so laid back they say right, I'll sign it for you, or the other extreme, which is far better from my point of view - and is what they did with K2A - which is for them to take the time out to decide what their requirements are. Once we've got a brief, it's our job to develop specifications and get them to sign off these specifications".[55]

Bolton's role in "coming up with designs" involved an examination of production requirements in considerable detail:

> "We listed all the functions that needed to go on in this building; whether its a cleaner's cupboard, a blending room, etc. We then listed the types of equipment needed for that function, how many people would be needed, and where that function would be best carried out. Then we listed all the services required, eg compressed air, nitrogen, 3 phase/single phase, etc, as well as floor and wall finishes and whether there are doors, windows, etc. There are Glaxo guidelines for lighting levels, air change rates, etc. All of those details go onto what we call 'room data sheets' which are one of the first real pieces of data that the external design team can use. From that information the architects did a series of sketches ..."[56]

Note the extent to which facility definition had progressed, both in terms of time - almost two years since Underwood's initial definition - and in terms of detailed requirements, prior to construction involvement.

5.6.4 K2A gathers momentum (Nov. 1988 to Jan. 1989)

By early November Parr had included K2A in Glaxo Pharmaceuticals' Capital Projects list. (The list noted the status of each project and, for K2A, noted not only that progress was dependent on Glaxo Holdings Board sourcing policy, but that the uncertainty of this policy was a potential 'block' on the project). It noted further that a Board paper was requested for a facility to produce 380 tpa.

Shields of Glaxo International Quality Assurance Division visited K and C blocks on 11 November and wrote to Cargill noting the likelihood of materials congestion in K2. In a memo to Hatfield, but copied to Chandler and Murray, Cargill attributes this to "the [K2] capital project being squeezed" and continues:

> "Given the very substantial expectations of ..[CAOS], let us not make the same mistake again through short term cost cutting measures simply to meet an initial project capital cost operation for K2A, which, to say the least, was a 'guestimate'."

In a covering note to Hatfield, Cargill noted:

> "The memo is aimed at others to make a point, as I am sure you will be aware. Indeed, if used constructively, Dr. Shields' comments can be used to good effect."[57]

A number of factors may be identified here as contributing impetus; the formal inclusion of K2A in Glaxo Pharmaceuticals' capital programme; confirmation that a Board paper was expected; Cargill's efforts to ensure that sufficient funding was obtained to provide a satisfactory facility.

The K2A design was now being progressed by the design team who met again at the end of November. Floor layouts and sketch proposals were being prepared by Dewhursts, based on draft room data sheets prepared by Bolton and Ball, in respect of some 6 schemes. By the design team meeting on 21 December 1988, efforts had focused on two schemes.

By the end of January there was still a good deal of uncertainty over what was to be accommodated and the two schemes were substantially different: one had a total floor area of 2030 square metres at an estimated cost of some £3m; the other a floor area of 3450 square metres at a cost of some £5m. The estimated costs for these schemes compared to Hatfield's proposal of January 1988 are shown in Appendix D.5. The main change from the 'conceptual design' on which work had started - by Hatfield and Laxton - about a year earlier was additional space for filling (to accommodate sachet filling made possible by the SLS formulation) and for materials storage.

5.6.5 Procurement and authorisation strategy (Jan. to Feb. 1989)

By mid January the larger scheme had been selected for design development and the architects and structural consultants commenced preparation of detailed proposals. Separate meetings were now being held between Ball and Melec Ltd to develop detailed environmental services proposals.

Hatfield had, for some time, been keen to progress the project on a 'fast-track' basis. The need for funding approval for K2A was becoming critical to progress if the target date for completion (mid 1990) was to be achieved. The 18 January design team meeting noted that steelwork would have to be pre-ordered in April to allow fabrication in time for an August start on site. Hatfield's programme of early January envisaged the preparation of the Development Project (DP) during January and February for submission in March and authorisation between March and July 1989. It envisaged a significant 'pre-spend' on design fees and on steelwork in advance of main board approval of the DP. Hatfield explained:

> "Pre-spends were authorised in the form of 'mini-DPs' which could be approved at lower levels in the company; for example, the manufacturing centre manager [Cargill] could approve up to £25,000 and the Factory Manager [Murray] up to £100,000. The main DP then 'mops up' all previous mini DPs and contains a total project budget, even though some of this money may have already been spent."[58]

Hatfield's 'authorisation strategy' was outlined in a memo to Chandler:

> "The following fast-track approach has been developed by the K2A Design Team:
> March
> Submit Holdings' Board Paper [DP] to yourself.
> Obtain authorisation of further design fees (£250k).
> April
> Obtain authorisation to order structural steel (£150k).
> July
> Obtain authorisation sufficient to appoint a Main Contractor (£50k).
> Obtain authorisation to lay foundations (£50k).
> September
> Obtain authorisation to erect structural steel (£150k).
> Obtain authorisation to order major process plant items (£1m).
> The September items assume that Holdings' Board approval has not been obtained at that time. If this approval is significantly delayed we may need to consider further prespends, eg to order HVAC plant."[59]

The construction procurement strategy envisaged letting separate contracts for foundations and structural steelwork in advance of the main superstructure contract.

Note that the 'fast-track' approach was defined primarily in terms of the approval of expenditure. Depending on the project duration and the time taken for Group Board approval, a fast-track approach such as this could, in theory, commit considerable expenditure in advance of formal top management approval. The point here, however, is that the expectation that approval would be forthcoming combined with the commitment generated by advance expenditure, contributed considerable impetus to the K2A project. Clearly, the investment 'context' permitted - and, indeed, encouraged - this; recall Glaxo's reputation for bringing products to market quickly and Nathan's comments about "time compression in the development phase" (Appendix C).

5.6.6 Wider developments and changes to 'structural context' (Mar. 1989)

By the beginning of March, Hatfield and Laxton had a clearer idea of the scope of the building work involved and were beginning to finalise agreements with consultants on this basis. The estimated building cost was now some £2.5 to £3 million (excluding design fees).

Process development work during February indicated that the moisture content of the granule was becoming a critical factor and that more extensive dehumidification plant than originally envisaged might now be required in K2A. This was confirmed at the Project Team meeting on 16 March (the Project Team were now meeting less frequently than the monthly basis heretofore).

At the 16 March meeting it was agreed that a formal Technical Working Party (TWP) be constituted for CAOS, with representation from the primary and secondary production sites, and GGR (see Figure 5.3a). This would have responsibility for ensuring successful production. This was one of Glaxo's first formal TWPs and on this project it was evolving and defining its own role. Hatfield explained:

> "The Technical Working Party effectively grew out of the K2A project. It was only formally established on K2A, although the functions, activities and inter-relationships of its component parts used to happen anyway. The pressure for TWP came from within TDD [Glaxo Pharmaceuticals Technical Development Division], not from above."[60]

The formation of the TWP may be seen in terms of a change to structural context and, while the source of this change does not appear to be at the top management level, it nevertheless arose out of the need for a co-ordinating function for a number of new product development activities. Specifically, previous commentary (sections 5.5.2 and 5.5.7 in particular) has identified a lack of co-ordination between process development, registration planning and market forecasting. The TWP, with its emphasis on co-ordination and representation from GGR (regulatory, development planning, pharmacy - process development), the manufacturing site, International Marketing Division, and TDD, is a direct response to this.

5.6.7 The K2A Development Project (DP) (Mar. 1989)

By 17 March the K2A DP was ready - in advance of the scheme design - and was submitted by Hatfield to Murray (see next section for a brief description of the approvals process). It requests a total capital expenditure of £7.8m in buildings and equipment.

The DP is in five parts. This is a confidential document and brief extracts only are presented in Appendix D2. Parts 1 and 2 were prepared by Hatfield and the site project team. These included a one page 'Project Authorisation Request' containing brief financial details and a recommendation to the Board to invest in the new facility. The investment is justified in terms of the inability of existing facilities to meet anticipated market demand. A brief description of the building and the process it will accommodate is provided, supported by 8 pages of sketches and drawings (7 of the building and 1 of the process) and a one page cost summary. A summary of Parts 3, 4 and 5 comprise the financial justification for the investment and were written by the Glaxo Pharmaceuticals Finance Department. Considerable financial detail is provided. Over the six year period indicated, the project would have a negative net present value and the DP concludes:

> "The project is not financially justified from a Glaxo Pharmaceuticals viewpoint."[61]

Hatfield explained:

> "The project represents a decision at Group Finance level[62] which is made by considering the overall implication for the Glaxo Group of investing in production facilities for this product."

Interviewer: Who decides on the viability of the investment?

> "The manufacturing centre is not a profit centre - its a cost centre. It therefore does not say how much an investment will return. It is part of a worldwide organisation where the centre will take a strategic view of the feasibility of individual capital investments".[63]

A strategic summary and project justification was written by Nathan. This was (and is normally) attached after the DP was submitted by the project manager but before it reached the (Pharmaceuticals) company managing director and board. It notes:

> "The critical availability date of January 1991 for the proposed facility at Barnard Castle can only be met by starting construction on the plant before the production process has been fully defined by GGR, and by progressing the project under fast-track conditions. As such, it represents a risk investment for Glaxo Pharmaceuticals."[64]

The main argument presented in the DP - and reinforced in Nathan's 'strategic' summary - is that the investment is necessary to provide new capacity to meet anticipated demand. It is written by facility-oriented managers and, although phrased in terms of capacity and facilities, it considers the proposed provision of UK facilities in the context of product demand and existing (and planned) Group facilities worldwide. In capacity terms, then, it may be said to take account of corporate level needs and concerns.

The extent to which top management expected to receive a proposal and the prior knowledge they would have of its contents was outlined by Bolton:

> "I think there's an informal sort of sounding out beforehand. I can't quite remember when the project was submitted, but somebody would ask for the informed opinion of someone like Stewart [Hatfield] just what a facility might cost. Stewart would indicate a figure just to see whether that was acceptable. And then there would be some sort of indication coming back as well as to whether that was in the right ball park."[65]

Project definition up to this point appears to have taken place within a 'business planning context' (see 4.3.3 above) set by top management wherein the market and the product (CAOS) to be sold in it have already been identified. Although this proposal arose from within Glaxo Pharmaceuticals, there are clear indications that top management encouraged the submission of a bid for capital investment funds for this product. For example, neither Nathan (nor Hatfield as principal author) mention return on investment (ROI) in the DP. Further, the calculation and presentation of the financial justification for the investment appears routine, parochial ("not justified from a Glaxo Pharmaceuticals viewpoint") and, ultimately, irrelevant. The history of cost escalation[66] without apparent reference to ROI criteria at company or Group level suggests that capital costs were not a primary consideration.

However, within this business planning context, an 'integrating level' process of "sounding out" has helped to confirm 'what the corporation wants of me' (see also Murray's 'assumption' in an earlier memo to Chandler that the project stood a reasonable chance of authorisation, section 5.5.4).

5.6.8 The role of 'pre-spends' (Apr. 1989)

A summary of pre-spends was presented in the DP, indicating those that had already been submitted for approval (totalling some £195,000 for design fees) and those that were to be submitted in April (totalling a further £550,000 for steelwork, substructure and management fees).

By mid April three 'mini-DPs' relating to pre-spends on K2A had been submitted: design costs (totalling £213,000); steelwork (£92,000); and substructure (£248,000). Ken Parr (the Glaxo Pharmaceuticals Finance Director) who had to sign each DP before forwarding to the Factory Manager for approval, suggested a rewording of the mini-DPs to indicate that each was part of a large project for which a main DP has been submitted:

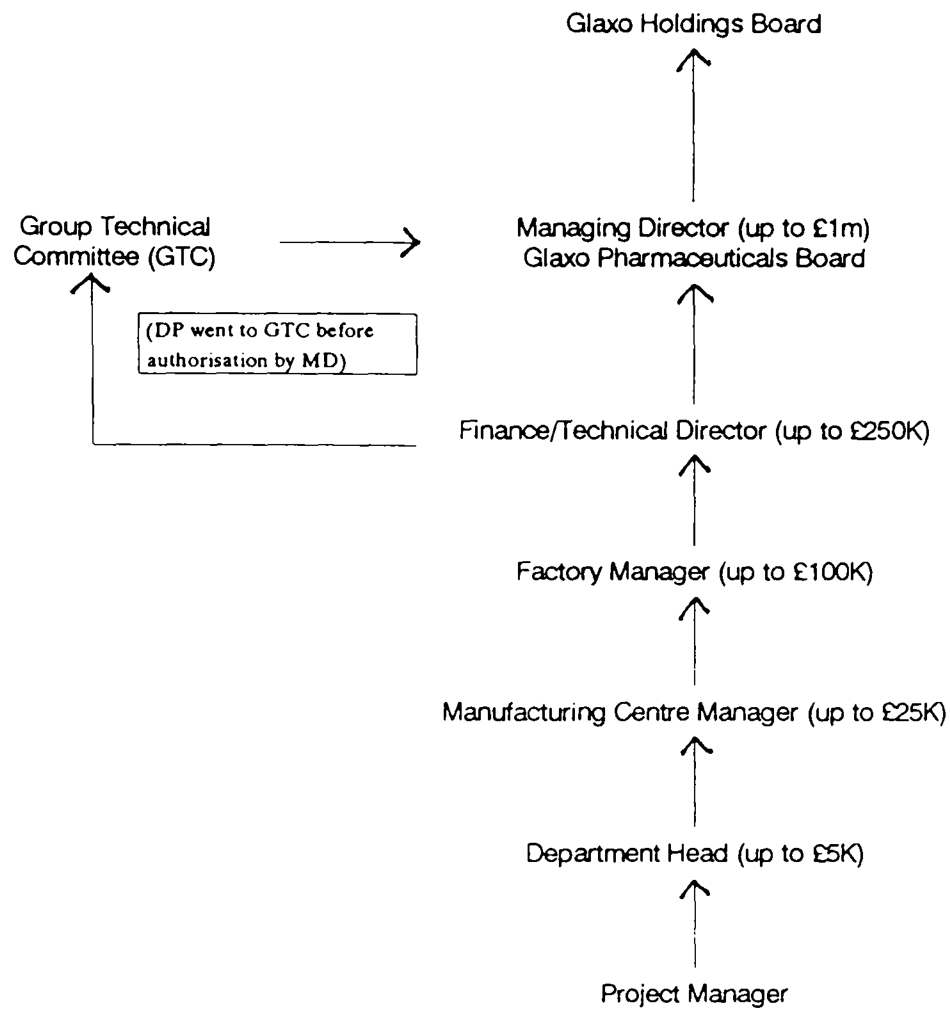
> "I believe we should make a clear statement that in the event of the main DP not being authorised the expenditure for each of the DPs in question will be written off and is therefore at risk. I believe this statement should read: 'In the event of the main DP for £7.8 million not being authorised any expenditure against this current DP will be abortive and subject to write off'."[67]

The formal procedure for the approval of pre-spends explicitly acknowledges the risk involved, ie, it is clear that the worth of the expenditure is dependent upon approval of the main DP. By approving these pre-spends, managers commit themselves and the resources within their control to the larger project. It is unlikely that they would do this without some indication that the main DP was likely to be approved. In doing so, however, the risk of 'writing off' pre-spend expenditure passes to top management who may then find it difficult to reject proposals to which a good deal of the corporation's human and financial resources are already committed.

5.6.9 The DP approvals process (March to Jan. 1989)

The formal DP approvals procedure is summarised in Figure 5.4 overleaf.

Figure 5.4 The K2A DP approvals process[68]



Note: Figures in brackets were the amounts which could be approved at each level without further – upward – referral.

Hatfield was asked who was responsible for progressing the DP through the approvals system:

> "The timing of the submission of DPs depends on when the Group Board sits, which is known in advance. SPU 'nurse' the project through the system in a bureaucratic sense, for example by ensuring that papers are with appropriate people by the specified time, and so on."

Interviewer: I recall that SPU also wrote the 'strategic summary'.

> "We would need to get the strategic people saying to the management committee [GTC] - which was a group committee not a Glaxo UK committee - that they supported the creation of this capacity at Barnard Castle. So SPU first of all give you the data which tells you what it is you need to do and then they support what you're intending to do - making recommendations to that committee, and that's what happened."

Interviewer: And that support was essential?

> "It would be very hard for a site to ask for what it thought was a local need without somebody saying 'how does this fit in with the rest of the world'? ... so when finally it [the DP] goes out with the support of the UK Board, on the one hand you've got strategic people calling for capacity and on the other hand you've got operations people asking for the money to do it. Most people high up are depending on good information being presented to them."

Interviewer: Is it common for proposals to come back down saying 'We need more information'?

> "Extremely uncommon."

Interviewer: They're either approved or not?

> "They're generally approved. The communication chains rely on dialogue - one to one - with a strong understanding between the key players (whatever level) - so that usually people know what's going to arrive and some of them meet before they ever see it."[69]

The K2A DP was approved by the Group Board at its meeting on 15 June.

The process of impetus for the K2A DP can now be summarised and clarified. First, there was an expectation by top management that a proposal was being submitted and a prior knowledge of what it contained. Secondly, there was a considerable level of financial commitment already made (and about to be made) in the form of expenditure on product and process development and pre-spends authorised by those managers who were also in the authorisation chain for the main DP. And thirdly, there was support from the Strategic Planning Unit for the creation of worldwide capacity for this product.

5.7 MAJOR CHANGES

5.7.1 Introduction and overview

Two major changes are the focus in this section, one occurring prior to final approval of the DP by top management, the other following approval and after work had started on site. Particular attention is paid to the 'impetus' required to get the project changed and the 'structural context' within which changes are made which are the subject of propositions D, G, H, and I (in section 3.4.2 above).

5.7.2 The origins of the batch plant change (Mar. 1989)

The description of K2A in the DP notes:

> "The internal structure of the building is designed around the main process plant, consisting of two 500kg batch size fluidised bed mixer-dryer-granulators."[70] [author's emphasis]

Since January 1989, estimates of capacity required assumed a single 1000kg machine for K2A. Indeed, there are references to a 1000kg machine in the DP and the process flow diagram presented describes a 1000kg batch size. Hatfield explained:

> "At the last minute the Managing Director [Chandler, of Glaxo Pharmaceuticals] argued that 2 x 500kg machines would be preferable to a 1 x 1000kg machine. Many in TDD felt that 1 x 1000kg had advantages, but John Parker also felt that 2 x 500kg would be better, and they both had the authority and influence to push this change through."

Hatfield felt that although the lack of confidence in the 1000kg proposal originated in GGR, as 1000kg was new for Barnard Castle, Chandler was also uneasy. As Managing Director Chandler was ultimately responsible

> "for meeting the needs of the market. He was effectively saying: 'I feel insecure about meeting market needs with a 1 x 1000kg process'".[71]

Tony Spackman, the project technologist concerned with process development recalled:

> "Most of the people thought that if we built this 1000kg tower and couldn't get it to work, we were up the creek without a paddle. People felt more comfortable with the idea that we were only going half the way. It was the first time that Glaxo had gone to machines of that size; 200/250kg was big by our standards, particularly in orals where things were done on 50/60 kg. So yes, I think there was a sort of historical hesitancy about going five-fold...and nobody could either stand up to or convince the Managing Director that his gut reaction was wrong."

Interviewer: He was ultimately responsible?

> "He signed the DP! He had to support the DP as it went to the Board."[72]

5.7.3 Implementing the batch plant change (Apr. 1989)

The batch plant change was incorporated between the release of the DP by Hatfield on 17 March and mid April. Part 1 of the DP refers to the 1x1000kg machine; Part 2, which is dated 17 April, features the 2x500kg plant. The 2x500kg configuration appears in the one page 'strategic summary' written by Nathan (see section 5.6.7 above) and dated 17 April.

The minutes of the 12 April K2A design team meeting note that the batch plant change was discussed. However, the implications for steelwork design and the design of the environmental services had not yet been assessed. The meeting minutes note that

> "Mr Hatfield informed the meeting that there was no more money on offer for this particular project and that the Managing Director was not prepared to go back to the Board for extra money."[73]

Hatfield also indicated that the project programme was not to be disrupted. Hatfield and Laxton had, in fact - with Hamburg & Co. - been assessing the likely additional costs of the batch plant change. By 13 April Laxton had confirmed that additional costs of some £1m would be needed (£0.5m building costs and design fees, and £0.5m equipment and validation costs). Chandler was reluctant to sanction any cost increase as a result of the change he initiated and confirmed this in a memo to Hatfield[74].

Note that the origin of the change lies in the 'insecurity' of a director whose <u>responsibilities</u> are facility-oriented, even if he had not been involved much in the detail of project definition. Further, he was supported by Parker who, as chairman of the Project Team and a considerable source of project momentum up to that point, contributed the necessary impetus.

Despite indications that significant additional costs might be needed, there was reluctance to sanction this financial change. Although *informants were somewhat reluctant to discuss the financial aspects of this change in much detail, it raises a number of questions. In particular, it was not possible to examine the extent to which such cost increases might have reflected poorly on managerial competence and, further, whether the implications of this would have been greater the higher up the hierarchy was the particular manager concerned. Indeed, it would appear that consequential cost increases were, in this case, directly attributable to the individual initiating the change.*

It would appear then, that while the technical content of the proposal could be altered at the eleventh hour, there was more reluctance to alter its financial content. (As will be seen, additional costs were, in fact, partly absorbed into cost increases required as a result of a later change.) However, at that time Hatfield appears to have had little choice but to insist to the design team that the budget remain unchanged. There was still a considerable amount of design development work left to do on the K2A building. Furthermore, in addition to a 2.5 per cent contingency on project costs (including equipment costs and professional fees), the £7.8m requested in the DP was permitted to fluctuate within a limit of ±15 per cent.

5.7.4 The origins of the fallow area change (Apr. to May 1989)

Both Hatfield and Laxton were away at the end of April. On 26 April Cargill asked Ball for an urgent costing by the following day for Chandler to present at the GTC meeting. This was for...

> "...the possible provision of a third 500kg granulation tower to be located within the K2A schematic design. This costing had to include only for the building shell and necessary services, but to exclude the production equipment."

Ball wrote to Hatfield summarising his response to Cargill:

> "I calculated that the building only would be in the region of £1.6m ±25 per cent. The time which I estimated it would take to incorporate this to a schematic design stage is 2 months from now. Mike [Cargill] stated he felt that the timing for completing the existing building [K2A] would have to remain as end of 1990. Everything happens when the two managers are away, but I will discuss this in more detail with you...on 2 May."[75]

Hatfield recalled that, although prompted by the possibility that Italy would not install CAOS production capacity, the desire for this 'fallow area' was in part:

> "an insurance against the forecasts being too low. The MD [Glaxo Pharmaceuticals] approached the Manufacturing Centre Manager to say he wanted the fallow area."[76]

Following the 2 May meeting, Nathan wrote to Laxton with a brief for the third granulation machine:

> "Italy may never happen, and Glaxo Inc will be at least one year late with their manufacturing facility. BC will need to be able to cover world demand until 1992/93. The least cost option to cover this is to add building space which is capable of housing a 3rd granulation unit. For planning purposes I would recommend that you size for a 1000kg unit, unless the costs are >20 per cent more than a 500kg unit. I understand that a cost of £1.6m - £2.0m would be welcomed and that SCC [Chandler] is visiting on Monday [8 May] to discuss."[77]

Contrast the more 'top-down' nature of the fallow area change, which concerns the provision of capacity for Group needs, with the more 'bottom-up' process of changing the batch plant, which is a more detailed technical change, though closely related to meeting market demand.

5.7.5 Implementing the fallow area change (May 1989)

At the design team meeting on 3 May Laxton requested Dewhursts to examine whether an extension could be added to K2A, but stressed that this change must not adversely affect the K2A programme. Dewhursts and Melec Ltd indicated that the dust extract room in K2A would need to be extended to accommodate the third tower, thus increasing K2A costs.

Dewhursts confirmed that the additional design work for the Fallow Area could be accommodated without affecting the programme for K2A; Allen & Co. felt that the programme of structural design would be affected. They estimated that an extra 3 weeks would be needed for changes to the foundation design. Laxton requested the design team to progress the design for the third tower and to incorporate the extra work in their respective contracts with Glaxo at fees to be negotiated.

By this time Hamburg & Co. had already issued tender documentation for the foundations contract and documentation for structural steelwork was due to be issued by 17 May. There was little time to revise this to incorporate the third tower change. The strategy agreed at the 11 May meeting was to proceed with the selection of the foundations and steelwork contractors on the basis of the documentation already prepared and to negotiate with each extra amounts for the fallow area. By the next design team meeting on 24 May this strategy was reviewed. The main concern was that the K2A project might be delayed by incorporating the fallow area change. The minutes note that :

> "It was agreed to leave out the third tower fallow area foundation works together with the steelwork [from the respective contracts]. This would be introduced into the main contractor's contract and may avoid an extension of time on the first two contracts."[78]

Hatfield recalled[79] his determination not to allow work on the fallow area to interfere with progress on the main contract for K2A. He pointed out that the main contractor was allowed to work on the fallow area in parallel with work under the main contract on this understanding. When asked how this was handled contractually, he replied: "We just told him." There was no separate agreement for the fallow area, nor was there any particular requirement in the architect's instruction to say that the main contract took precedence.

5.7.6 The fallow area DP (May to Nov. 1989)

Following the 11 May design team meeting, Hatfield and Laxton began preparation of the fallow area DP and a mini-DP for changes to the dust extract plant room in K2A. By 26 June a DP had been prepared by Laxton, signed by Hatfield and sent to Murray for approval and release along the normal authorisation chain. It requests expenditure of £1.2m "to provide additional cephalosporin orals manufacturing capacity at Barnard Castle"[80] in a 580 square metre, three storey, building shell-only extension to K2A. It notes that the K2A project had "recently been authorised" (on 15 June 1989). It is in a similar - though less bulky - form to the K2A DP.

Although it is not clear from the documentation available how the total sum requested - £1.2m - was arrived at (it is greater than the quantity surveyors' cost estimate), it would appear that not all was needed for the fallow area. Laxton recalled:

> "We lost about £800K on the two tower change but we recouped some of this on the fallow area."[81]

If the search here was for neat theory relating the size and costs of production facilities directly to the demand for the products to be produced in them, it is very difficult to see how the origin and management of both of the changes reported here could be accommodated within it. Neither can such behaviour be explained solely in terms of narrow self interest; the readiness with which Glaxo Pharmaceuticals appear prepared to develop a production capability for this product has an element of (at least) company-level strategy about it. The willingness and the ability of relatively senior management to intervene in the facility definition process is further indication of an investment process spread across many levels of the corporation's hierarchy.

The fallow area DP had a somewhat different passage along the authorisation chain than the K2A DP. In particular, the finance director (Parr), in a memo to Chandler, challenged the proposal's lack of clarity - it identified three possible uses for the fallow area - and its failure to address why other Group facilities would not be available. However, by the beginning of August market forecasts had been further revised indicating a clearer requirement for the fallow area (see Appendix D.3).

When the fallow area DP went before the Glaxo Pharmaceuticals Board on 16 August, it had been revised to focus on one use - CAOS production. Forecasts of market demand now indicated that Barnard Castle would be out of capacity for peak demand by 1992. However, alternative uses (tablet manufacture and packaging) for the fallow area continued to be considered. Primarily because of this, no indication of the costs of or revenue from sales was provided, and the viability of the investment was therefore not explicitly considered.

Authorisation for expenditure on design work necessary to modify K2A to allow for the fallow area extension had, of course, already been requested by Laxton. The fallow area DP notes:

> "The cost of the knock-on effects [to K2A] has been estimated at £240,000 and has already been committed to ensure the K2A completion date is met. To this end, a pre-spend against this project has been submitted and approved."[82]

The fallow area DP was approved by the Group board on 17 November 1989.

The lack of explicit financial justification for the fallow area investment is notable; as Hatfield remarked, the need for "insurance against the forecasts being too" low would appear to have been given further support by the revised forecasts at the beginning of August. In these terms, the need for investment is more concerned with the potential loss of market share than the financial return anticipated.

5.8 GETTING THE K2A FACILITY BUILT

5.8.1 Introduction and overview

Following the two major changes just reported, there remained a considerable amount of detailed design development work to do which took place in parallel with work on site. Attention is now paid to how further design development was managed within the funding limit available and, in particular, how the 'structural context' between Glaxo and construction firms was determined to facilitate change. These matters are the subject of propositions H and I (in section 3.4.2 above).

5.8.2 A review of wider issues (Jul. to Aug. 1989)

By the summer of 1989, the project to launch CAOS had become quite complicated. There were at least 4 separate major projects being progressed in parallel at Barnard Castle:

1. The construction of the main K2A facility
2. The construction of the 'fallow area' extension to K2A
3. Modifications to K2 block for CAOS manufacture
4. Modifications to C block for early (1990) launch stocks.

In addition, there were smaller, related projects associated with filling and packaging in K block:

5. The conversion of the K1 bottling line to CAOS filling
6. The installation of a sachet filling line in K1.

Furthermore, development work continued at Glaxochem and GGR as follows:

7. Development and improvement of the product formulation
8. Development of the primary manufacturing process at Ulverston
9. Development of the secondary manufacturing process by GGR at Barnard Castle.

Outside of the UK, work progressed - though at a slower pace than in the UK - on:

10. Formulation development and facility planning in the USA
11. Facility planning in Italy.

Additionally, the registration of CAOS in all major markets prior to launch was a major preoccupation for GGR's Regulatory Affairs Division, with a series of clinical trials and registration testing in up to 20 different markets. Although Marketing Division had updated the launch dates and demand requirements in respect of each market, precise details of packaging and dosage requirements had not been confirmed by the end of July 1989.

Towards the end of August demand forecasts were again revised, indicating further increases overall and in 1990 in particular. Graham Leigh (of Marketing Division) had written to Glaxo companies in all markets in June requesting revised demand forecasts:

"It is important to realise that to underestimate your highest potential demand could lead to a shortage of production capacity. Therefore we would urge a boldly realistic forecast."[83]

The new forecasts received in response to Leigh's request were summarised by Hatfield in a memo to the Barnard Castle team:

"Recent increases in the forecasts for this new product have placed enormously increased pressure on our project. We must bring forward as much capacity as possible into next year - whereas previously 1991 was the key year... K2A must be completed to programme. These requirements are at the limit of possibility. Our total commitment is called for. In the light of the complexity and size of the task, may I emphasise that John Laxton is the overall Project Manager."[84]

5.8.3 Changes in the CAOS project organisation (Aug. 1989)

The increasing complexity of the entire project for the launch of CAOS was also a source of concern to Murray (whose responsibilities included a range of products manufactured at Barnard Castle). Indeed, there were increases anticipated in demand for other related products around this time which threatened further pressure on secondary manufacturing resources generally. Murray met with Hatfield, Nathan, and Roberts (who was managing manufacturing operations in respect of CAOS) to determine the action necessary to meet CAOS launch requirements.

This meeting led to the appointment of Kevin Frosini (a business planning manager from Glaxo Operations) to the CAOS project in early September as logistics expert. Frosini had been involved in the preparation of capacity estimates with Hatfield, Laxton, Nathan and others. Now his role was more explicit. Bolton recalled:

"Kevin was given the job of a site executive person - almost without portfolio. When it became clear that there were so many facets to this particular project, it was felt that as well as having a project manager specifically for K2A, we ought to have some sort of a supremo that took away from the manufacturing centre managers the responsibility for long term planning."[85]

Although Frosini's appointment was more concerned with the planning and co-ordination of secondary manufacturing operations rather than construction matters, it helped to clarify roles and responsibilities.

Frosini also took over responsibility for capacity planning and this was to result in a reduction in the estimate of capacity required to be provided at Barnard Castle. In particular, by examining strategic stock holding policies and persuading markets to accept lower strategic stocks, he was able to alleviate pressure on secondary production capacity.

Note that Murray, whose responsibilities cover all manufacturing at the Barnard Castle site, identified an urgent need for the planning and co-ordination of secondary manufacturing for this product. This led directly to a change to 'structural context' with the appointment of Frosini to a planning and co-ordination role.

5.8.4 Procurement of K2A construction work (Jun. to Sept. 1989)

By 12 June the foundation contract[86] had been let to Tower Construction and work had started on site as planned. Hatfield recalled that foundations presented particular difficulties due to the extent of existing underground services and that Tower Construction:

> "weren't the lowest, but the lowest hadn't even bothered to visit the site".[87]

Structon submitted the lowest tenders for structural steelwork by 31 May and were appointed on 26 June (on a similar basis to Tower Construction) following Hamburg & Co.'s tender analysis and recommendation.

Work on site on the foundations contract was delayed by the redesign of the structure to accommodate the fallow area extension, and this had a knock-on affect on the steelwork contract. The structural engineers pointed out at the design team meeting on 26 July that since the steelwork tender documentation had been issued, the total tonnage had increased by some 20 per cent during the development of detailed design. Structon were now concerned about meeting the programme for steelwork erection.

The main contract was to be let on a similar basis to the foundation and steelwork contracts. Although the intention was to incorporate the fallow area work into the main contractor's tender documentation, Main Board approval had not been provided shortly before going to tender. Hatfield requested Hamburg & Co. to introduce a separate section within the bills of approximate quantities for fallow area work to enable this to be priced separately. Although the intention was to select three contractors to bid for the main contract, Hatfield was becoming concerned that the complexity of the project and the extent to which changes were being (and were likely to be) introduced could cause problems on site. He was keen to ensure that the availability of K2A for production (by January 1991) would not be compromised. He decided to negotiate directly with Tower Construction - who were about to complete the foundation contract:

> "We needed the security of negotiation - Tower Construction had built K2 and knew their way around that. There was considerable insecurity coming from the Managing Director in particular; however the launch dates and volumes required were critical, and we didn't want a contractor whom we couldn't be sure about. I sold the idea to Gilbert Healey - who was my boss at that time - on this basis."[88]

Hatfield's handwritten notes for his meeting with Healey identify the benefits he perceived in negotiating with Tower Construction:

> "Previous knowledge/performance. Link to Melec Ltd [M&E designers and installers on K2A]. Reduced conflict/cost."

To this list he added the (presumably personal) aphorism:

> "Negotiation buys performance and co-operation. Tendering buys conflict."[89]

Hamburg & Co. had written to Hatfield prior to his meeting with Healey confirming their approach to negotiation, which included the requirement that Tower Construction would seek competitive quotations for trades they would normally sub-contract (eg brickwork, finishes). This was partly so that Hatfield could demonstrate to Healey that negotiation would not preclude competitive prices.

The main contract bills of quantities were issued to Tower Construction on 19 August; negotiations commenced in the week beginning 11 September. Hatfield was keen to conclude negotiations to permit a start on site of 15 October; however, towards the end of September, approval for the fallow area extension had still not been received. Hatfield therefore instructed Hamburg & Co. to reach agreement with Tower Construction on the basis of their tender excluding fallow area work. Laxton recalled:

> "The fallow area was handled as a variation - the main contract was signed without it."[90]

Hamburg & Co. had negotiated reductions of some £0.19m and agreed a contract sum of £3.26m on 29 September (see Appendix D.4). The contract eventually signed was a standard JCT form (see footnote 86) with provision for Glaxo to arrange third party insurance for both client and contractor. There were no other special provisions or requirements.

Although Hatfield stressed to colleagues at the end of August that "Laxton is the overall project manager", Hatfield was still prepared to become involved in key decisions (eg the selection of the main contractor). Laxton, by contrast, was around this time more directly involved in detailed matters of construction.

By 'selling' the idea of negotiation to Healey, Hatfield was reconciling the needs of the project - completion on time - with the needs of the corporation - demonstrating that costs are competitive. In this 'integrating level' activity may be seen the beginnings of a form of 'determination of context'. Recall proposition I; the context at issue here is that set of agreements which determine the relationship between client and contractor. Negotiating to secure agreement with a known and trusted contractor in this instance appears to have helped relax the formal agreement between them: "we just told him" not to let Fallow Area work interfere with the main contract.

5.8.5 Overall progress and design development (Sept. to Oct. 1989)

By early September the K2A foundation contract was complete and Structon were on site and had commenced steelwork erection. Design development was by now considerably advanced and Dewhursts had finalised the 1:50 scale floor plans and were now working on dimension drawings. Quotations were being invited for lifts, wall and roof cladding and air conditioning units around this time. The intention was for Glaxo to place orders directly with major material/component suppliers.

Detailed design on K2A progressed throughout October. Dewhursts informed Glaxo at the design team meeting on the 18th that Structon were about 2 weeks behind on the steelwork programme; this meant that the earliest the main contractor could start on site would be 30 October and that the overall completion date would be later than anticipated. By the end of October, Tower Construction had commenced main contract work on site. Design team meetings continued, and Laxton, Bolton and Ball all continued to have very detailed input into design development, including equipment design and installation. Bolton outlined the extent to which he and Ball were involved in this:

> "When it got to the point where we had architect's drawings, ones that we were actually going to implement and build, it was Don [Ball] and I who would actually go to Dewhursts' office and spend the whole day going through with a fine tooth comb, scale rule and bits of card actually making sure this would work and so on. Really, in the utmost detail. My own view is that a lot of the strain, from a project management point of view was taken from the project manager by the rest of the team. Certainly I've seen teams working on smaller projects where the project managers have had to handle the whole thing."[92]

Bolton and Ball were also extensively involved in the detailed development of the M&E services design and had been holding separate meetings with Melec Ltd outside of the main design team since early in 1989. Following the issue of Melec Ltd working drawings on 20 October, they negotiated in some detail to achieve cost reductions as the latest drawings indicated more costly provision than the earlier estimates. For example, they rejected a suggestion of a £40,000 saving by omitting separate dust collection plant and reverting to dust collection on filters. The extent to which they were unprepared to compromise their requirements is also indicative of the detail to which they were prepared to define them. Bolton, in a memo to Laxton noted:

> "Early experience with K2 showed this to be poor engineering practice... The K2A design brief stated dust collection prior to HEPA filtration. Please adhere to our earlier considered request for true dust separation and collection."[93]

5.8.6 Further revisions to market forecasts (Oct. 1989 to Feb. 1990)

Although further revisions to demand forecasts had little direct impact on the K2A programme, they are reviewed briefly here because of their significance up to now and their overall importance to capacity planning.

In parallel with K2A construction work, Frosini was now involved in detailed planning for the product launch. He had, since October, formalised the reporting of demand forecasts in a CAOS 'Demand/Capacity Review' and had involved Glaxo Customer Services in obtaining product volume information from major markets. On 12 December he issued his second review which noted that the demand for 1990 launches - the source of considerable concern only some 5 months earlier (in August) - had now been reduced by some 50 per cent (see the Forecasts Graph, Appendix D.3). One of the main causes of this change was that France and Spain - together accounted for over 40 per cent of 1990 demand - had postponed launches from August and October 1990 to October 1990 and January 1991 respectively.

Early in 1990, launch dates and volumes in major markets had still not been confirmed. Revised forecasts were available by the TWP meeting on 21 February indicating that the Italy launch had now been postponed to January 1991 (from October 1990) and that 1990 demand has fallen by a further 26 per cent since December (see the Forecasts Graph, Appendix D.3). This had immediate implications for work on C block which was intended to cater for the large 1990 demand anticipated in August 1989. The question of how demand forecasts and launch dates were determined was also discussed at the TWP meeting. Prior to the involvement of Customer Services, launch dates and volumes were provided by GGR Regulatory Affairs who contacted the markets primarily to ascertain regulatory approval dates. The meeting noted:

> "The impact of revised dates and forecasts was emphasised when it was pointed out that current volumes for 1990 now stood at only 34 per cent of the demand being forecast in October 1989, and if Italy does not launch until 1991 this figure reduces still further (to 14 per cent of the October 1989 forecast)."[94]

The difficulty in predicting accurate regulatory approval is noted in the minutes; estimates of approval dates are provided from data based on recent approvals for different products. It was agreed that Regulatory Affairs would restrict their predictions to approval dates only and that Customer Affairs would concentrate on launch dates and volumes.

There appears to have been no overall co-ordination of forecasts of sales volumes and launch dates, at least until Frosini involved Customer Services in November 1989. Also, Leigh's request for a "boldly optimistic forecast" may have encouraged markets to overstate their requirements. Hatfield thought that the problems experienced with this product were part of the "normal uncertainties" associated with a new product launch. However, he noted that responsibility for forecasts of volumes and launch dates now rests with "a single group" within Glaxo Manufacturing Services[95].

5.8.7 Progress and delays with K2A (Feb. to May 1990)

Work on site throughout the winter and early spring of 1990 progressed broadly to programme with no major change and no formal indication of significant delay or disruption. Laxton recalled:

> "There were many minor changes as the design developed, but they were all minor detail really. There was nothing as big as the two towers or the fallow area. Hamburg & Co. tried to agree all the variations as they were issued and provided monthly statements showing actual against anticipated expenditure."[96]

However, by May 1990 Tower Construction's progress reports indicated that the record of inclement weather now accounted for some 3 working weeks. Further, the granulation equipment suppliers were behind schedule on both the modifications to the existing K2 equipment and the supply of new equipment for K2A. By the end of May Tower Construction had contacted Hatfield indicating that inclement weather and delays with delivery of granulation equipment had seriously disrupted the construction programme, by some 14 weeks.

Hatfield felt that he had been given little prior warning of the extent of the delay and he met with Dewhursts and Hamburg & Co. to review the cause. The programme of May 1989 had envisaged a July 1990 completion (the building contract includes a 20 July date of completion). He then called a meeting between Tower Construction, Healey, and Dewhursts at which an extension of time of some 10 weeks - to 8 October - was agreed.

Laxton recalled that the installation of the granulation plant as construction work proceeded had not been thought through sufficiently and integrated with the contractor's programme. He felt that there was a lack of detail in the programme - major activities were only described in terms of their start and finish times, with no detailed breakdown provided to enable detailed monitoring of progress[97]. Additionally, site progress meetings were held only every three weeks. Hatfield, in a memo to Murray and Healey reviewing the delay, noted the action taken to help prevent a recurrence:

> "1 The contractor's plans are now on a 4 weekly rolling basis and fully networked.
> 2 Weekly programme meetings are now being held to supplement the three-weekly site meetings.
> All future large contracts will be managed in this way."[98]

The revisions to demand forecasts in February - indicating a postponement of peak demand - tended to relax the constraints on the timing of K2A construction work. The 10 week delay does not seem to be as critical as it might have appeared a few months earlier. Note the extent of Glaxo involvement, however, and the extent to which it was seen appropriate to revise some aspects of 'structural context' - programmes and meeting arrangements.

5.8.8 Work to completion

At the end of May, Cooper (of CMC) wrote to Healey pointing out that £600,000 was included in the K2A DP for an extension to K block offices - which was not to be provided under the present contract - and requesting an assurance that this money remained available. Healey asked Hatfield to reply. Hatfield confirmed:

> "Our anticipated final cost for K2A has always included a provision of £600,000 for the office extension. The project is overspent following the later change from one to two GGT towers. The site may therefore, in the future, need to resist a suggestion to reduce the overspend by eliminating the office extension. I assume that we would all agree with this."[99]

Hamburg & Co. cost reports indicate steadily rising costs as construction work progressed towards completion, associated largely with architect's instructions and the implementation of detailed building and M&E services design. The certificate of practical completion was issued on 30 October. During the 'snagging' period, minor modifications were still being requested. Early in December 1990, Laxton wrote to Bolton:

> "K2A is now rapidly approaching a 10 per cent[100] overspend situation. Some 'nice to have' items, eg replacing painted guards with stainless steel ones, etc will have to wait until the financial situation has been resolved."[101]

5.9 POSTSCRIPT

Hatfield and Laxton met with Chandler at the end of August 1990 to review the K2A construction project. Their presentation material for that meeting notes the complexity of the project in terms of the parallel development of the manufacturing process and market forecasting. The overrun of 10 weeks is noted as being less than the K2 and K3 projects (17 and 7 months respectively) and both managers declare themselves pleased with the performance of the consultants and contractors.

During interviewing in 1992, the project had been in production for some 15 to 18 months and there had been continuing problems with the computer controlled process plant. Furthermore, all informants agreed that the K2A process plant was one of the most automated in Barnard Castle and that the requirements for the validation of computer systems and software in particular had been underestimated. Cannon explained that the requirements of the FDA for validation had become more stringent in recent years and that Glaxo had, as a consequence, developed a Group validation policy:

> "..basically the process of validation is to prove and document that every part of the process and every piece of equipment performs as it is designed to do. We've found ourselves in the situation now where we are having to do retrospective validation on some equipment that we have already got in. There is a concern with the K2A facility about the documentation regarding the computer controls of the plant, simply because at the time that we were going through that part of the process we weren't as aware of the need for validation as we would be today."[102]

Further revisions to market forecasts occurred throughout the final stages of the K2A construction project and subsequently. The postponement of product launches in France and Italy in particular meant that the C block capacity would no longer be needed as initial volumes required were not as large as anticipated. Late in 1992, however, there were indications that K2A might soon be out of capacity and Hatfield was working on a DP for the installation of a third granulation machine in the fallow area.

5.10 FOOTNOTES

1 Glaxo Holdings Plc (1986), pp5-8.

2 Glaxo Holdings Plc (1990) and Glaxo Corporate Communications Department (1990), p10.

3 Measured in terms of total sales which amounted to £2854 million in the financial year to June 1990 (Glaxo Holdings Plc, 1990, p5).

4 Data are from Glaxo Holdings Plc (1990); monetary amounts are current prices.

5 Reference Publishers International Ltd (1988), p639.

6 Glaxo Laboratories' factory at Barnard Castle was one of the first to mass produce penicillin by the deep fermentation process (cf Glaxo Manufacturing Services Ltd, 1986).

7 Glaxo Holdings Plc (1990).

8 In discussion with the author, 1992.

9 CAOS Product Prospectus, 1987, unpublished.

10 In discussion with the author, 1992.

11 In discussion with the author, 1992.

12 In discussion with the author, 1992.

13 Glaxo internal communication, 11 December 1986.

14 All quotes are from the minutes of the Task Group meeting on 23 December 1986.

15 There are a complex set of factors influencing the choice of packaging, including regulatory issues (the product must be chemically stable in the pack in which it is to be sold, for example), cultural preferences and pharmaceutical practice in different markets, all of which have a bearing on the form and size pack and the equipment which will fill it.

16 Glaxo internal report, February 1987, unpublished.

17 Minutes of the Task Group meeting on 9 February, 1987.

18 In discussion with the author, 1990.

19 In discussion with the author, 1992.

20 Glaxo internal communication, 24 February 1987.

21 Minutes of the Project Team meeting on 15 may 1987.

22 Minutes of the Project Team meeting on 17 June 1987.

23 Quotes in this section are from Glaxo internal communication, 19 June 1987.

24 Quotes in this section are from Glaxo internal communication, 29 July 1987.

25 Quotes in this section are from Glaxo internal communication, 7 August 1987.

26 In discussion with the author, 1992.

27 Glaxo internal communication, 20 November 1987.

28 In discussion with the author, 1990.

29 Minutes of the Project Team meeting on 27 November 1987.

30 Minutes of the Project Team meeting on 4 December 1987.

31 Glaxo internal communication, 24 December 1987.

32 Glaxo internal communication, 4 January 1988.

33 Glaxo internal communication, 5 January 1988.

34 Glaxo internal communication, 26 January 1988.

35 Glaxo internal communication, 27 January 1988.

36 Glaxo internal communication, 26 January 1988.

37 Glaxo internal communication, 2 February 1988.

38 Minutes of the Project Team meeting on 17 April 1988.

39 GGR's Regulatory Affairs division (represented on the Project Team) were responsible for co-ordinating and progressing the registration programme. They were responsible for compiling the International Registration Dossier and New Drug Approval documents (IRD/NDA; see Appendix C) and for the co-ordination of registration in up to 20 major markets. Submission of PLAs/NDA and the identification and administration of any necessary clinical work was carried out locally by local Glaxo companies.

40 Glaxo internal communication, 28 June 1988.

41 Glaxo internal communication, 23 June 1988.

42 Hatfield (in discussion with the author 1990), explained 60 per cent capacity utilisation:

> "This is standard Glaxo procedure to cater for future increases in demand; the capacity estimated is such that if market forecasts are realised they will only use 60 per cent of it. This has proved fairly reliable over time and achieves an acceptable balance between cost and potential utilisation."

43 Glaxo internal communication, 28 June 1988.

44 Hatfield outlined the background to locating production in two European sites - UK and Italy - (in discussion with the author in 1990)

> "There is a lot of 'insurance premium' thinking in capacity planning. The Company does not like putting all its eggs in one basket. Italy was merely a duplication of facilities, to hedge against a major accident."

45 Quotes in this section are from Glaxo internal communication, 25 July 1988.

46 Glaxo internal communication, 5 August 1988.

47 Glaxo internal communication, 22 August 1988.

48 Glaxo internal communication, 17 October 1988.

49 Glaxo internal communication, 29 September 1988.

50 In discussion with the author, 1992.

51 In discussion with the author, 1992.

52 Note that, although Reid was 'design team leader', Hatfield and Laxton, as site project managers, were responsible for the management and co-ordination of all CAOS related projects at Barnard Castle in terms of design, construction, equipment installation and commissioning.

53 Glaxo internal communication, 4 November 1988. Hatfield explained the emphasis on completion of the scheme design (in discussion with the author, 1990):

> "Generally for building projects - including this one - we prefer to have a scheme design with a QS's cost plan before approaching the Board. We prefer also to have M&E people on board at this stage".

54 In discussion with the author, 1992.

55 In discussion with the author, 1992.

56 In discussion with the author, 1992.

57 Glaxo internal communication, 15 November, 1988.

58 In discussion with the author, 1990.

59 Glaxo internal communication, 3 February, 1989.

60 In discussion with the author, 1990. A Glaxo working paper outlines the TWP role as one of managing and co-ordinating the installation of reliable production processes, the production of registration samples, initial launch stocks and the provision of market forecasts in terms of sales volumes and pack requirements.

61 The K2A DP, 17 March 1990, unpublished. The apparently poor cash flow arises from the calculation of sales revenue which is on the basis of UK sales only. Product not sold in the UK - some 90 per cent of the total - is transferred to Glaxo Export at 'standard cost', which would be considerably less than the drug's market value. Note that Glaxo Pharmaceuticals is the UK manufacturing and marketing company; although it manufactured product for sale in other markets, this was transferred either to Glaxo Export or local companies for sale there.

62 Access to Group board level was not granted, nor were the Group Finance papers seen.

63 In discussion with the author, 1990.

64 The K2A DP, 17 March 1990, unpublished.

65 In discussion with the author, 1992.

66 Note that total expenditure requested in the DP - £7.8m - is considerably more than previous estimates - from £3m-£4m in November 1987 to £5.7m in June 1988 (see Appendix D.5).

67 Glaxo internal communication, 13 April 1989.

68 Hatfield, in discussion with the author, 1990, outlined the GTC role in the approvals process:

> "The Group Technical Committee's function was to ensure that the project fitted-in technically; this is not a financial approval".

69 All quotes in discussion with the author, 1992.

70 The K2A DP, 17 March 1990, unpublished.

71 In discussion with the author, 1990.

72 In discussion with the author, 1992.

73 Minutes of the design team, 12 April 1989.

74 Glaxo internal communication, 12 April 1989.

75 All quotes in this section are from Glaxo internal communication 28 April 1989.

76 In discussion with the author, 1990.

77 Glaxo internal communication, 3 May 1989.

78 Minutes of the Design Team meeting, 24 May 1989.

79 In discussion with the author, 1992.

80 The fallow area DP, 26 June 1989, unpublished.

81 In discussion with the author, 1992.

82 The fallow area DP, 26 June 1989, unpublished.

83 Glaxo internal communication, 8 June 1989.

84 Glaxo internal communication, 23 August 1989.

85 In discussion with the author, 1992.

86 JCT 80 (Private with Approximate Quantities).

87 In discussion with the author, 1992.

88 In discussion with the author, 1992.

89 Hatfield's notes, c.August 1989.

90 In discussion with the author, 1992.

91 In discussion with the author, 1992.

92 In discussion with the author, 1992.

93 Glaxo internal communication, 6 December 1989.

94 Minutes of the TWP meeting on 21 February 1990.

95 In discussion with the author, 1992.

96 In discussion with the author, 1992.

97 In discussion with the author, 1992.

98 Glaxo internal communication, 15 June 1990.

99 Glaxo internal communication, 7 June 1990.

100 The 15 per cent permitted overspend at the time the DP was approved had subsequently been revised to 10 per cent (see commentary in section 5.7.3).

101 Glaxo internal communication, 10 December 1990.

102 In discussion with the author, 1992.

5.11 CAOS/K2A: CHRONOLOGY OF KEY ACTIVITIES

1986

December	Parker forms GGR Task Group for CAOS Underwood identifies need for new facility for CAOS

1987

January	Underwood defines new facility for CAOS
February	Glaxo Inc in USA to be likely site for CAOS secondary manufacture Project Team formed
May	Doubts about the USA as source of CAOS secondary production Barnard Castle (BC) to manufacture CAOS launch stocks
June	Chandler indicates 'proposal' for BC facilities expected
July	CAOS not bio-equivalent to tablet; longer registration inevitable
September	Team formed at Barnard Castle to plan facilities for CAOS
November	Increased market forecasts require extra capacity at BC Need for K2A identified
December	Estimates indicate existing capacity unable to support launch

1988

January	Hatfield obtains support from Murray for investment in K2A Architects involved in K2A design development Alternatives to K2A examined Nathan supports investment in K2A
February	Problems with packs and process development
April	Budget of £5m for K2A in Glaxo Pharmaceuticals 5 year plan
May	SLS added to CAOS formulation - sachet presentation now feasible USA launch postponed to 3Q 1990
June	USA launch postponed to 4Q 1990; RoW postponed to 3Q 1990 Doubts about the need for K2A following news of launch revisions Nathan confirms that K2A still required
July	Queries from GTC about the need for facilities at BC and Italy
August	Hatfield and Laxton define 1000kg granulator as preferred option Project engineer (Ball) joins BC facilities team

1988 (cont'd)

September	Continuing uncertainties over pack types and sizes
October	Pack types clarified
November	First formal K2A design team meeting Bolton CMC Customer Representative Cargill does not want "short term cost cutting" on K2A

1989

January	Two K2A schemes examined Authorisation programme for 'pre-spends' identified
March	TWP constituted K2A CAR (DP) submitted Change in batch plant specification (2x500kg) incorporated
April	Steelwork, substructure and management 'pre-spends' submitted Fallow area change initiated
May	Design, etc changed to incorporate fallow area
June	K2A DP approved by Glaxo Group board K2A foundation contract let and commenced on site K2A steelwork contract let
August	New market forecasts indicate clearer need for fallow area Fallow area DP revised and submitted Frosini appointed to plan secondary manufacturing operations
September	Negotiations commenced with main contractor for K2A Foundations complete/steelwork commenced on site
October	Main contract works commenced on site
December	Downward revisions to market forecasts

1990

May	First indications that main contractor behind programme Extension of time agreed - from 20 July to 8 October
August	Project management review of K2A
October	Certificate of practical completion for K2A issued

1991

January	First CAOS production batches manufactured in K2A

5.12 KEY PERSONNEL FEATURED IN CAOS/K2A CASE STUDY

Glaxo personnel

Name		Affiliation/function
Ball	D	Glaxo Pharmaceuticals/project engineer
Bolton	S	Cephalosporins Manufacturing Centre (CMC)/customer representative
Cannon	C	Glaxo Group Research (GGR)/development planning
Cargill	M	CMC manager
Chandler	C	Glaxo Pharmaceuticals/managing director
Clarke	P	Glaxo Holdings/GTC member
Cooper	B	CMC/accountant
Frosini	K	Glaxo Operations/business planning and logistics
Girolami	P	Glaxo Holdings/chairman of the board
Hakim	J	Glaxo Inc/USA representative (occasional) on Project Team
Hatfield	S	Glaxo Operations/facilities project manager
Healey	G	Glaxo Operations/facilities planning
Holden	R	Glaxo Pharmaceuticals/packaging
Laxton	J	Glaxo Operations/facilities project manager
Leigh	G	Glaxo Holdings/marketing development and forecasting
Lewis	J	Glaxo Pharmaceuticals/packaging
Murray	J	Glaxo Operations/Barnard Castle factory manager
Nathan	M	Glaxo Operations/resource planning
Parker	J	GGR/chairman of CAOS Project Team
Parr	K	Glaxo Pharmaceuticals/finance director
Perotti	V	Glaxo Italy/Italy representative on Project Team
Roberts	M	CMC/operations manager
Samuelson	D	Glaxo Inc/USA representative on Project Team
Shields	A	Glaxo Holdings/international quality assurance
Spackman	T	Glaxo Pharmaceuticals/technology transfer
Starkey	J	Glaxo Holdings/marketing development and forecasting
Underwood	R	Glaxo Pharmaceuticals/technology transfer

Consultants, contractors and suppliers

Name/firm	Role
Dewhursts	Architecture
Hamburg & Co.	Quantity surveying
GGT	Granulation equipment
Allen & Co.	Structural engineering design
Reid P	Architect and design team leader
Tower Construction	Groundworks and main contract
Melec Ltd	M&E services design and installation
Structon	Steelwork

CHAPTER 6: VICKERS DEFENCE SYSTEMS AND PROJECT DREADNOUGHT

6.1 INTRODUCTION AND OVERVIEW

This case study is about the role of Vickers Defence Systems (VDS) in the decision and implementation stages of a capital investment project involving the construction of a new factory building for the manufacture and assembly of armoured fighting vehicles (AFVs). The building was constructed in Newcastle during 1981 and 1982 on a site some 1.5 miles from the existing VDS manufacturing facility and as a replacement for it. The new building was equipped with production machinery from the existing facility - little or no new production technology was involved.

The construction of the new facility - the Armstrong Works, codenamed project 'Dreadnought' by VDS - was initiated by Gerald Blackmore following his appointment as chief executive of VDS late in 1980. This case study covers the period between late 1980 and late 1982 when the building was completed and occupied. During this period, Blackmore undertook a wide ranging review of the VDS business; the construction of Dreadnought was central to this review. It eventually involved the transfer of production operations out of the company's outdated Elswick works and was accompanied by large reductions in the workforce.

Unlike Glaxo's K2A project just discussed, there were few major changes once the scope of the facility required began to be defined in detail. This case study was selected to examine the study propositions in a situation where change did not occur during the construction process.

A brief chronology of key activities is presented in section 6.10 below. A list of key personnel featured in this case study is presented in section 6.11.

6.2 COMPANY PROFILE

6.2.1 Introduction

Vickers Defence Systems is the defence division of Vickers Plc, a largely British-based engineering company with international headquarters in

London. Altogether some 27,000 people were employed by group companies in 1980. The company was ranked 128 in the Times 1000 in 1979-80. Vickers's largest single market is the UK, which accounted for 45 per cent of sales in 1980 (43 per cent in 1981)[1].

6.2.2 Organisation and structure

In 1980, the company was diversified across a wide range of engineering activity and organised into 5 groups: Engineering Equipment, Engineering Products, Howson-Algraphy (lithographic material), International, and Motor Cars[2] - see Figure 6.1. Activities included the manufacture of marine engineering components, railway wagons, printing presses, battle tanks, rocket motors, office equipment and precision components such as fibre-optic measuring devices and electronic medical equipment. The Engineering Group - containing the Defence Systems division - was the single largest in terms of sales and profit in 1980, accounting for 31 per cent of sales and 38 per cent of profits[3].

6.2.3 Vickers Defence Systems and tank manufacture

Vickers have a long history in the armaments industry (Scott, 1963). The manufacture of battle tanks in particular has been a central Vickers activity since some of the earliest tanks for World War I were manufactured by Armstrong-Whitworth in their Elswick works on Tyneside in 1917 (the site of Vickers Defence Systems tank production until 1982)[4].

During the 1960s an increasing proportion of work connected with the design, development and manufacture of battle tanks for the British Army - a major Vickers customer - was awarded to the Government's Royal Ordnance factories, and VDS began to concentrate on export opportunities. This involved the company in the development of its own designs and in collaborative ventures with other manufacturers. Such ventures have helped lay the foundations for an emerging manufacturing strategy. VDS now concentrate on the manufacture of certain components, and supply these components separately, or assembled into finished vehicles, often incorporating other components manufactured by their competitors[5].

Figure 6.1 Vickers Plc 1980

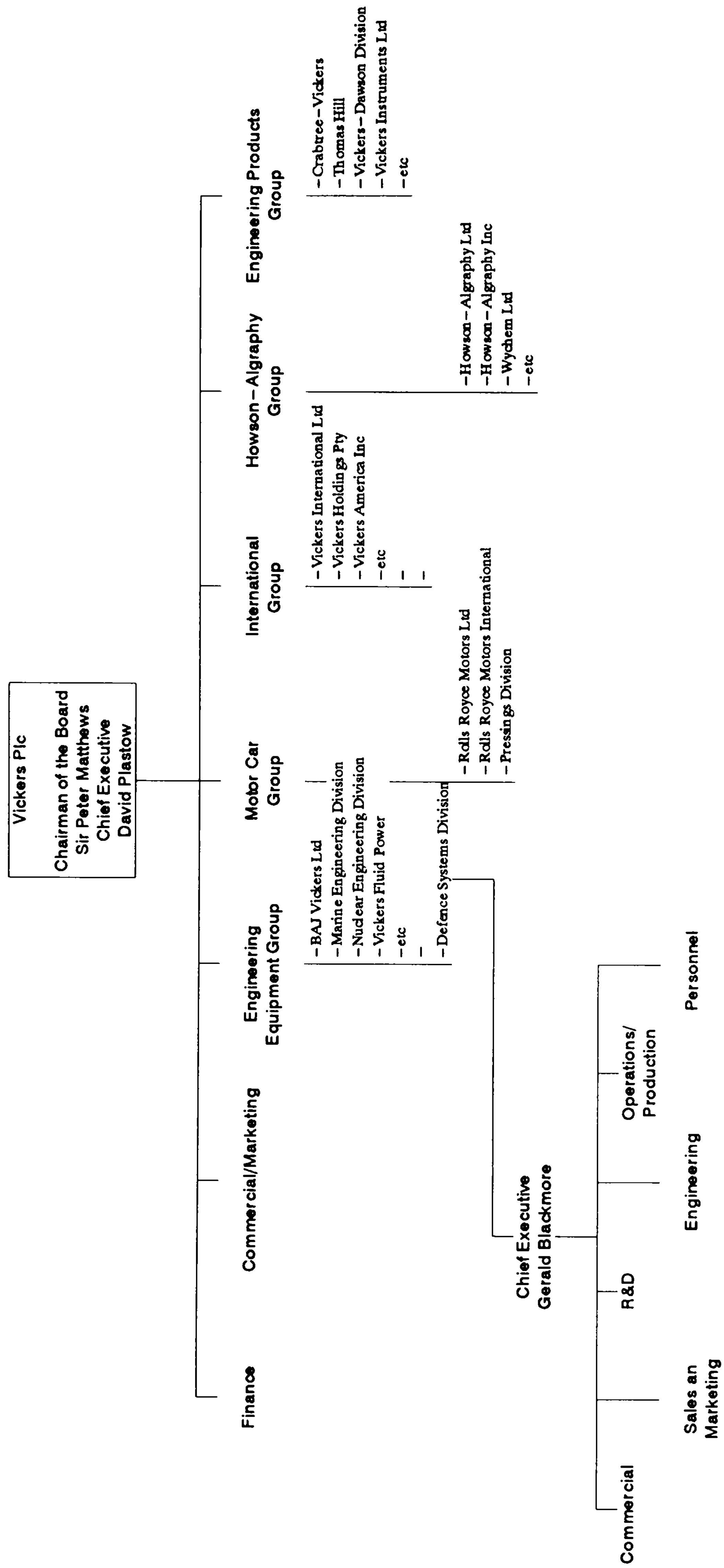


Figure 6.1: Vickers Plc 1980

Collier (1980) notes that although the design and development of modern weapons and weapon systems has become complex and sophisticated, the same does not apply to their manufacture. Jim Preston, Deputy Managing Director at VDS Leeds works, explained that a high proportion of the sophisticated components in a Vickers tank are bought in for assembly:

> "We make something like 8000 different items for each tank. We buy in just over 5000 items. In value terms, we buy in about 80 per cent of our product - we don't make engines, optronics, electronics, weapons. We make hulls, turrets, lots of mechanical items, hydraulic items; and we do the assembly."

Preston thought that the extent to which VDS manufacture the mainly mechanical, low value-added components set them apart from their competitors:

> "None of our competitors are organised the way we are [in production terms]. Some of them, like in Germany, just have an assembly plant; they buy in the components and stitch them together. In the States they do a little bit more, some of the fabrication and some of the large machining, but virtually everything else is bought from outside."[6]

Preston saw this concentration on mechanical manufacture as the VDS core business following naturally from the company's antecedents in the steel and engineering industries. It fitted well with their manufacturing strategy, continued by Gerald Blackmore throughout the 1980s of seeking collaborative ventures with other producers. This allowed VDS to develop a somewhat unique and specific expertise - eg in turret design and manufacture; their turret was chosen for the latest development of Challenger - and to seek wider opportunities for sales than if they had concentrated on providing complete vehicles. Given the increasing sophistication of tank design and development, it also allowed them to avoid some of the high R&D and capital investment costs associated with market leadership.

6.3 BACKGROUND TO PROJECT DREADNOUGHT

6.3.1 The late 1970s

Throughout the 1970s VDS had remained profitable, helped in the latter half of the decade by a substantial order from the Kenyan government (placed in 1977) for the Vickers Main Battle Tank (VMBT) Mark 3. By 1980, however, the Kenyan order was almost complete. The cancellation of a large order placed by Iran with Royal Ordnance - some of which was to have been subcontracted to VDS - following the overthrow of the Shah of Iran in 1979 had left VDS seriously short of work. Stuart Willis, VDS commercial director at that time, recalled:

> "The management of the Engineering Equipment Group were concerned about the lack of future orders and our high level of operating costs. We were in clapped out premises at Elswick which the company occupied since before the First World War. Because of the decline in the business since the early 1960s, we were left with a legacy of underinvestment stretching back almost 20 years."

Interviewer: So there was a crisis in the business which prompted a review?

> "It is not really correct to describe the situation as a 'crisis'. Everybody knew there was a potential crisis if they cared to look far enough ahead. Our very high operating costs [in the old Elswick premises] had to be tackled sooner or later. Because of the long term contract nature of our business, the lack of large orders around 1980 meant that the business could not survive very long in the old premises."[7]

Note that the management of the Group (as well as of the Division) were aware of the high costs of operating in the existing facility. As will be seen, the need for a new facility is identified partly in terms of a discrepancy between current and potential operating costs.

6.3.2 1980 - Changes at the top

Throughout the 1970s, Vickers had been undergoing changes under the leadership of Sir Peter Matthews, changes which were accelerated with the appointment of David Plastow as chief executive in 1980. Plastow had been put in charge of Rolls Royce Motors by the British government following nationalisation in 1970[8]. By September 1980 Vickers had acquired 90 per cent of Rolls Royce Motors and shortly afterwards Plastow became chief executive of Vickers Plc. Willis recalled:

"A job for Vickers used to be a job for life. Vickers had a reputation for looking after their staff, not necessarily in terms of wages, but more in terms of long term welfare - pensions, sickness benefit, and so on. This has changed in recent times, especially since the arrival of David Plastow and, before him, Peter Matthews. There are now better financial rewards, but these are more related to performance."

But the changes made by Matthews and Plastow were not solely to do with remuneration. Willis continued:

"The divisions and groups of companies were more controlled by the centre prior to Matthews and Plastow. Plastow, in particular, wanted to put chief executives into the various businesses whom he could then leave alone to get on with things."[9]

Goold and Campbell (1987) chart the evolution of Vickers from a holding company into a 'strategic control' company under Plastow. The characteristics of strategic control companies include the devolution of responsibility for strategy development to the divisional and business level, and the requirement that capital projects are generally proposed by the businesses[10]. John Hammond, the VDS Financial Controller, recalled that:

"The pre-Plastow regime was generally unsupportive of suggestions for capital investment. Plastow felt that the division was stagnating; he appointed Gerald Blackmore as chief executive to do something with the [VDS] business."[11]

Blackmore was appointed chief executive of VDS in December 1980. Willis recalled that he was transferred from another part of the Engineering Equipment Group (Fluid Power division):

"as being the right man for the job at Defence Systems. He was immediately given the brief of: 'What do we do with the existing armoured vehicle business? Should it be wound up or should it carry on?'"[12]

Blackmore had previously been appointed to undertake similar reviews of two ailing Vickers divisions - Michell Bearings and Fluid Power. In both divisions, manufacturing operations were being carried out in old and unsuitable premises; and in both cases Blackmore perceived that investment in new buildings was an essential part of the re-organisation necessary to ensure continued survival. His review of Defence Systems led directly to a proposal for the construction of a new factory.

Goold and Campbell (1987) argue that in Strategic Control companies, radical initiatives involving business closure are more likely to come from the centre than from the businesses. They argue further that an important corporate role is the allocation of managerial resources[13]. *Taken together, these propositions pose a dilemma for the interpretation of Blackmore's appointment: was he appointed to review the business or - on behalf of corporate management - to close it down? His previously successful 'rescue' efforts are perhaps significant; Willis, who indicated that Blackmore was the "right man for the job" added, when questioned further, that "there was nothing sinister in his appointment"*[14]. *Notwithstanding the subsequent history, the interpretation then is that corporate management viewed the Defence Systems division as one with growth and profit potential and appointed Blackmore to identify how best this could be exploited.*

6.4 DREADNOUGHT: THE PROCESS OF DEFINITION

6.4.1 Introduction and overview

In contrast to Glaxo's K2A project, the scope of the new facility required by VDS was defined very quickly. Following his appointment to Defence Systems in December 1980, Blackmore set about his new task as chief executive with characteristic vigour. Within a very short period he had defined in some detail (see below) the new facility required and by the end of February 1981 he had prepared and submitted a capital appropriations request (CAR) for funding approval. Ten days after submitting the CAR, the proposal was endorsed by the Executive Committee of the Vickers Main Board. Four months later a main contractor had been appointed and work had started on site. And one year after that a large (34,000 square metre) new factory building had been completed and manufacturing operations had been transferred from the VDS Elswick works.

This section concentrates on the management of the definition process which is the subject of propositions A, B and D (in section 3.4.2). A brief discussion of Blackmore's involvement in capital investment projects at both Michell Bearings and Fluid Power is presented as relevant to an understanding of his approach to investment at VDS.

6.4.2 Prologue: The Michell project

The Michell project marked the beginning of a relationship between Blackmore and Ted Nicholson, an architect partner with a Newcastle-based firm of architects and engineers, the Wright Nicholson Partnership (then known as Wright Bates and Partners). By the time Blackmore had been appointed to VDS, both men had developed a close working relationship which was, according to colleagues, characterised by a high level of mutual professional respect and which was to prove significant in the management of the Dreadnought project.

Nicholson recalled that in 1973, Wright Bates had advised Michell Bearings against accepting a design and build proposal from a contractor for the construction of a new factory on Tyneside. Wright Bates were very concerned about the contractor's proposals, particularly because of the absence of a soil survey for a riverside site where the ground conditions were expected to be problematic. Nicholson advised Michell to have a soil survey carried out immediately, and also to commission the preparation of an outline design and tender documentation as the basis for inviting competitive bids[15]. Nicholson felt that the contractor's proposals were based on an optimistic assumption of good ground conditions and that inadequate provision was therefore made for the conditions likely to be encountered.

Around that time Blackmore was appointed as chief executive of Michell and endorsed Wright Bates's proposals:

> "He understood very quickly what needed to be done, that there was a clear role for us on design and build schemes in defining employer's requirements."

Wright Bates were appointed to prepare an outline design and tender documentation. Tenders received were lower than the contractor's bid which Wright Bates had been asked to review. By this account, Wright Bates's first involvement with Vickers was a happy one. Nicholson recalled that:

> "Gerry [Blackmore] and I hit it off straight away; its partly to do with 'personal chemistry'; and its partly to do with the relationship we have, which is an equal partnership."

Prior to his appointment to VDS, however, Blackmore was transferred to the Fluid Power division where he enlisted Nicholson's help for the design and procurement of new premises, though this time on a smaller scale than at Michell. Nicholson recalled that Blackmore was interested in hearing about VDS plans to refurbish their ageing Elswick works around this time:

> "Gerry was contemptuous of this approach; he was very appreciative of the contribution a new building could make. Elswick was full of decrepit sheds, many of them dating from the First World War. He and I looked at the site [when Blackmore was still at Michell] to see what could be done."[16]

6.4.3 Early stages: The belief in new facilities (Dec. 1980 to Jan. 1981)

The problem facing Blackmore on his appointment in December 1980 to review the Defence Systems business was not an unfamiliar one, and he had already contemplated the problem of refurbishing the existing Elswick premises. He formed a small team to include himself, Stuart Willis (Commercial Director) and John Hammond (Financial Controller). Hammond recalled that there had been no formal preparatory work connected with this review prior to Blackmore's appointment (no documents relating to this review prior to December 1980 was seen by the author). Hammond, however, felt that Blackmore was keen on capital investment in new premises from the beginning:

> "Once appointed, Gerald [Blackmore] believed in investing in a new facility or else the business would die."[17]

Nicholson recalled that Blackmore contacted him early in January 1981 to help develop proposals for a new factory. Although the refurbishment of Elswick was considered - and presented as an option in the CAR (see below) - Blackmore's belief in the benefits of new premises appears to have been firmly rooted from the outset. There were a number of closely related elements to this.

The first concerned the image of modernity and efficiency which a new facility might project to existing and potential customers. Willis recalled that:

> "He had done it all before at Michell. He was convinced of the difficulty in attracting new orders on the scale needed to maintain the business if we continued to operate out of our old premises."[18]

Although the order position at the beginning of 1981 was not promising, there was the possibility of a significant order from the Nigerian government - for which production might commence in 1982. Additionally, GKN were negotiating with the British Army for the supply of 'mechanised combat vehicles' under a programme called MCV-80 and it was likely that VDS would be asked to supply turrets for 1000 vehicles by the mid 1980s. Blackmore, in the CAR submitted to the Vickers Executive Committee in February, wrote:

> "...but the question is on our present cost structure and geographical layout - how do we get to 1985? We cannot go on persuading people of our aspirations to be a credible source of hardware systems without an outward manifestation of our intentions and to do this we must make a major change in direction. I simply do not believe that we will even get to 1985 to take advantage of the business opportunities."[19]

Secondly, Blackmore saw Elswick as a serious constraint on the development of a business which, in his view, had future profit potential. He believed that it was costly to operate and that it was inherently unsuitable for modern manufacturing. A new facility would bring benefits in terms of production efficiency and lower operating costs. There were obvious production penalties in the movement of people and material among Elswick's sprawling collection of machine shops and stores, compared to modern, purpose-designed production facilities.

Thirdly - and fundamentally, given the nature of what Blackmore proposed to do - Blackmore perceived that the structure and organisation of the systems and personnel operating the Elswick works were inextricably linked to that factory's in-built inefficiency. Only by substantially changing the existing building - or by moving to new premises - could these systems be changed. Nicholson recalled that the Elswick site reflected powerfully the division's hierarchical structure. He described the directors' offices and dining facilities as "four storeys of isolated Victorian splendour" and noted that in other areas of the works different functional groups had thrown up "defensive corrals" around their activities. Nicholson continued:

> "Gerry felt that there were lots of people propping up a redundant organisation. They had a fire brigade of 30 people; their medical centre was a cottage hospital."[20]

Willis noted the extent of the security staff which were required to police the sprawling Elswick site. He added that a large number of redundancies followed Blackmore's review (see below):

> "He went down to the very basics, asking what activities do we really need to run this business, who does them and can they be done more efficiently? Everything was looked at."

The review was carried out very quickly. Willis recalled that Blackmore was adamant this had to be done early on while he [Blackmore], as a newcomer,

> "was still somewhat remote from the business; otherwise he felt he would become part of the organisation, he would get too close to it and tough decisions would be difficult."[21]

Finally, Blackmore and Nicholson felt that the costs of refurbishing the Elswick works would be as much - if not more - than a new building. Nicholson recalled:

> "We did a back of the envelope calculation for the refurbishment option, which really wasn't on. We quickly got to £8m and we were still counting.[22]

Although the 'discrepancy' triggering facility definition can be identified in terms of costs, this does not fully describe the initiating phase of the definition process. Blackmore's prior belief in the value of *new facilities in helping to achieve the radical re-organisation of the business he felt was necessary is fundamental. Only by physically moving operations out of the Elswick works could the working practices, structures and inbuilt inefficiencies which had become so intertwined with the existing facility be changed. Arguably, the discrepancy concerned structural context as well as costs. Note that there is no mention of a discrepancy in capacity terms (as on K2A); note also that Blackmore, as the source of definition, could not be considered a 'facility-oriented' manager in the 'Bower' sense.*

6.4.4 Alternatives identified and considered (Jan. 1981)

Blackmore, Willis and Hammond identified and examined five options, separated into 'downside' (closure) and 'upside' (continuation) options. The most extreme downside option was immediate closure, which could be complete by 1982. This would obviously have denied any future opportunity for profit potential and, as Blackmore noted in the CAR:

> "...is a 'final decision'. This admits that we can never get away from our abnormally high cost base and archaic systems which concedes that the problem is unsolveable. ...this denies us the long-term benefits in the future which, historically, have contributed fairly substantially ...to the Vickers Company."

The 'upside' option of continuing in business at Elswick was simply a superimposition of the likely Nigerian order on the current situation and Blackmore felt that this was postponing the problem:

> "...hoping that we will find a better solution in 1984/85. I do not think that we will ever get a better opportunity to make this radical change.."

The other three options all involved capital investment in a new factory; more specifically, these 'options' were really only different demand scenarios which might follow a decision to invest in a new factory. Two of these were 'downside' options - the first considered the eventuality of insufficient orders being obtained to sustain the business. In this case the new building would be sold as a general purpose engineering facility, probably at a loss. The second considered a fully equipped new factory having reduced manning levels to the minimum required to meet the current commitments. However:

> "...key designers and salesmen - are retained as an overhead to promote the main strategic activities."[23]

This was the 'downside' option which Blackmore found most acceptable. It provided a new facility with the capability of meeting potential future demand at a cost of some £1.5m per annum. This was some £1m less than the option of staying put at Elswick (without the Nigerian order).

6.4.5 Recommendation

The 'upside' option Blackmore considered to be definitive involved retaining a large workforce which, whilst substantially less than at Elswick, would still be capable of meeting a large order demand. The superimposition of the Nigerian order on this situation would generate a pre-tax profit of some £6m per annum by 1984.

Blackmore wished to retain as much as possible of the 'line' workforce directly involved in production related activities. The more 'peripheral' activities at Elswick would either be closed down because they would no longer be required in the new factory (eg building maintenance, fire brigade) or scaled down and 'contracted-out' because of improvements in efficiency or advances in technology (eg catering, security). Willis recalled that there were some 30 security staff at Elswick; a more secure site with a single building and video cameras, etc, required a security staff of 5 to 6 personnel. Hammond recalled:

> "The overheads were very high at Elswick - maintenance, security, payroll, etc. Most of the redundancies were on the 'ancillary' side - accounting, information management, costing, payroll, security, etc. The manufacturing side was less affected."[24]

Willis and Hammond calculated that the operating costs of the new factory - including redundancy costs - would be about £3m per annum less than at Elswick, due largely to:

1 staff costs: £2.2m

2 energy costs: £0.4m

3 annual building maintenance: £0.4m

On this basis, investment in a new £6m-£7m facility would have paid for itself in under three years, all other things being equal.

Although informants spoke of Blackmore's belief in the value of the benefits of a new facility, it would appear that such belief, whilst apparently strongly held, did not on its own provide sufficient justification to top management for major capital investment. Indeed, it will be seen that no attempt was made to place a financial value on many of the benefits identified; perhaps this was because the comparison of operating costs 'before and after' provided such a powerful case on its own for capital investment. In the event, the case for investment was made in the kinds of financial terms which top management can be expected to understand and to act on. This is not to imply that there was a 'hidden agenda', but simply to note that there were factors in the decision to invest other than those that were measured financially in the CAR.

6.4.6 Site and building scope (Jan. 1981)

The Power Press and General Engineering Division of Vickers occupied elderly engineering works on an otherwise redundant site on the Scotswood Road, adjacent to Michell Bearings. This division was due to close with the loss of all 215 jobs. The land was owned by Vickers Properties. This site was some 1.5 miles from the Elswick works and, although the costs of redevelopment were expected to be similar at both sites, Blackmore favoured the Scotswood Road site as providing a more prominent position on Tyneside for the new facility.

One of the first key considerations was to define the scope of the building needed, given the uncertainty in the order situation. Blackmore involved the manufacturing director, Harry Halroyd, and his production colleagues Peter Carlton (production engineer) and Bill Dawes (works engineer) to help identify accommodation requirements. Carlton recalled:

> "The two key determinants of the size and shape of the factory were the site and the maximum monthly production rate."[25]

Carlton recalled that a minimum production rate of three vehicles per month would have kept the business viable. However, Blackmore needed to establish the maximum likely production rate; Willis recalled that the building was sized to produce up to ten tanks per month as the "presumed maximum that the business would ever need". It was certainly in excess of VDS's likely production demands at that time.

Interviewer: Is it normal practice within Vickers to 'oversize' production facilities?:

> "Not necessarily - certainly not in Rolls Royce Cars, for example. However the nature of our [tank production] business is such that large variations in throughput occur and the factory needs to be able to accommodate them. This is typical of any 'long term contract' business."

Willis went on to point out that their experience indicated they must always be able to handle a double order, ie two large contracts at the same time. Furthermore, he noted that tank production was a lengthy process involving over 50,000 operations on some 13,000 items; the real constraint, he felt, was a shortage of skilled operatives. If extra space was needed, he felt it could be "added on at the end [of the new building] relatively quickly".[26]

However, the size and shape of the Scotswood Road site also exerted a strong influence on the layout of the new factory in particular. The elongated rectangular shape (see site layout, Appendix E.1) dictated a linear production flow. Carlton recalled:

> "This flow is not necessarily - or ideally - linear; we could have had a square arrangement if the site had permitted. There are production penalties with a linear arrangement, particularly crane interference when large items have to 'double back'."[27]

6.4.7 Early design development (Jan. 1981)

Early in January 1981 Blackmore asked Carlton to begin preparing factory layout schemes based on the capacity required, the site constraints and the sketch plans he was helping Nicholson develop. Carlton recalled that the approach was to build in additional production capacity where the constraint was likely to be greatest.

With a linear production arrangement, there is an implied sequence of operations commencing with heavy fabrication of armoured steel, machining and finally assembly of finished products (see Appendix E.1). Although production capacity can be increased by subcontracting, there are constraints on what VDS can sub-contract: there are national security considerations in both the fabrication and assembly areas, for example[28]. Additionally, Carlton pointed out that VDS have important manufacturing expertise in both small/medium machining and final assembly:

> "We will not sub-contract assembly operations, as this is where our critical know-how is. Giving away small machining would ultimately undermine our very important spares work."[29]

However, rearrangement of machine tools in the middle third of the factory space, combined with shift working can help increase capacity considerably. Carlton felt that the greatest production constraint is in the fabrication/large machining area, where the large, immovable machine tools are located. The approach was therefore to build in extra capacity in this area to provide enhanced production capacity overall. Willis recalled that Blackmore was working closely with Nicholson on the preparation of an outline design for the new factory as details of how production was to be organised were worked out. He (Blackmore) was keen to develop the design to a stage which would allow an accurate estimate of capital costs before approaching the Vickers Executive Committee with a proposal for funding.

Once the overall size and outline production flow had been determined, Carlton pointed out that the next key decision was the factory cross-section:

> "Our first decision was to segregate the heavy, medium and light manufacture. This pushed us towards having one large centre bay, and two smaller side bays. The centre bay width needed was 25 metres, and 15 metres each for the two side bays. The cranage requirements were 50 tonnes in the centre and 20 tonnes on each side; once you had your clearances (from floor to hook) in each bay, you then had your cross section." (see Appendix E.1)

Once these studies began in earnest:

> "it was apparent that every inch of the site would be needed to accommodate all the machines".[30]

There are a number of important observations which may be made here on the definition process which differs markedly from that reported on the K2A project. First, the extent to which senior management were involved in both the initiating and integrating phases of definition appears much greater on Dreadnought. Whereas top management were involved in K2A in setting the business planning context within which products requiring investment emerged from the research company, their role appears more direct and deliberate in this case. To a large extent top management have identified the discrepancy ('something needs to be done'); the involvement of facility-oriented managers lower down the hierarchy in this activity is barely discernible. However, "everybody knew there was a potential crisis" according to Willis, and this rather widespread knowledge may have contributed to the identification of the discrepancy leading to Blackmore's appointment.

Secondly, the approach to sizing the new facility, without reference to specific market forecasts, was very different from K2A. For Dreadnought, the factory was sized with reference to the maximum throughput likely to occur, and the historic need to accommodate a double order. Although both the K2A and Dreadnought facility definitions are uncertain, each relates to its individual industry needs. The Dreadnought definition was (as will be seen) geared more towards accommodating likely fluctuations in throughput in the longer term.

Thirdly, the production process and technology were well known with Dreadnought and the definition process was consequently more straightforward than on K2A. Although Dreadnought - because of site constraints - required a re-organisation of production, the machinery and production operations to be accommodated were well known.

Fourthly, compared to K2A, the definition process on this project has taken a very short time. A proposition arises. It is that the higher the *managerial level at which projects get defined, the faster they will move toward funding. However, speed of definition in this case has an additional element associated with it; recall that Blackmore wanted to complete his review before he became "too close" to the business. His seniority and authority allowed him to force the pace and there is a sense in which he generated his own impetus (see section 7.3 below).*

Finally, the dominant industry consideration affecting the K2A definition process may be said to be Glaxo's position of competitive advantage in the development of new pharmaceutical products. Their strategy of bringing products to market quickly, and the consequences of parallel working for activities of process development, registration and facility design and acquisition had a strong influence on the way in which the definition process was initiated and managed. By contrast, the dominant industry characteristic affecting the definition process on this project would appear to be the long production cycle and the low volume/long term nature of orders. In summary, Glaxo manufacture to sell a large volume of product into a variety of markets simultaneously; Vickers manufacture low volumes to order.

6.5 DREADNOUGHT GATHERS IMPETUS

6.5.1 Introduction and overview

This section of the case covers a period of about six weeks (mid January to the end of February 1981) during which the Dreadnought CAR was prepared and submitted to the executive committee for approval. It examines the role of the project sponsor (Blackmore) in this, as well as the role of top management to explore the source and nature of the 'impetus' which moved the Dreadnought proposal toward funding. Material presented is therefore directly relevant to a consideration of propositions C, D, E and F (in section 3.4.2 above).

6.5.2 Securing commitment: Finance and timescale (Jan. to Feb. 1981)

As the facility definition developed during January, it was becoming clear that the scale of capital investment required would be substantial.

Nicholson had involved Alan Jones of the JNC Partnership - a quantity surveying firm with which Wright Bates had a long standing association - for the provision of cost advice and quantity surveying services shortly after Blackmore had contacted Nicholson early in January. Early cost estimates indicated that a capital budget in excess of £6m would be needed for building costs alone. Blackmore and Willis were confident that financial assistance from the Department of Trade and Industry (DTI) would be available and Willis began negotiations with local DTI officials who indicated that support might be forthcoming. This was to contribute significantly to project costs - see below.

Late in January 1981 the project became known as project Dreadnought. Blackmore wanted an early completion - it was becoming clear that the financial justification for the investment would depend on comparing the high operating costs at Elswick with a low cost alternative; it followed that the faster the new factory could be made available, the quicker VDS would be able to reduce their fixed cost burden. Additionally, the fall in workload due to the completion of the Kenyan order and the time it would take to bring the Nigerian order - if received - up to full production provided a gap in orders towards the end of the summer of 1982 when the complete relocation of operations would cause the least disruption to production. Willis recalled that, additionally, the new building was required by September 1982 at the latest if the costly operation of firing-up the boilers at Elswick for the new heating season was to be avoided. Because of the need for site clearance and investigation at Scotswood Road, the earliest the site would be available to commence building work would be early summer 1981. Nicholson reckoned that the fastest time in which the new building could be built was about one year. He recalled:

> "Gerry said to me: 'this factory will be half as big again as Michell, and I want it in half the time. How would you do it?' He put this to me as a personal challenge. My initial thought was to tackle this with a design and build contractor, but we would do the M&E services, and we would also do all the architecture."[31]

Jim Preston recalled:

> "For any project, he [Blackmore] would always try to commit you to a date. I've got this book which Gerald stumbled across in the

library. Its a record of the King of Nepal's visit to see the sea trials of the Dreadnought[32]. ...it says from laying the keel to going out on the first sea-trials took 366 days. So he turned around and said, 'well, if they can bloody well do that, without CAD, there's no reason why we can't do the same'. It was typical of Gerald, really, and how he would try and get people committed to a date."[33]

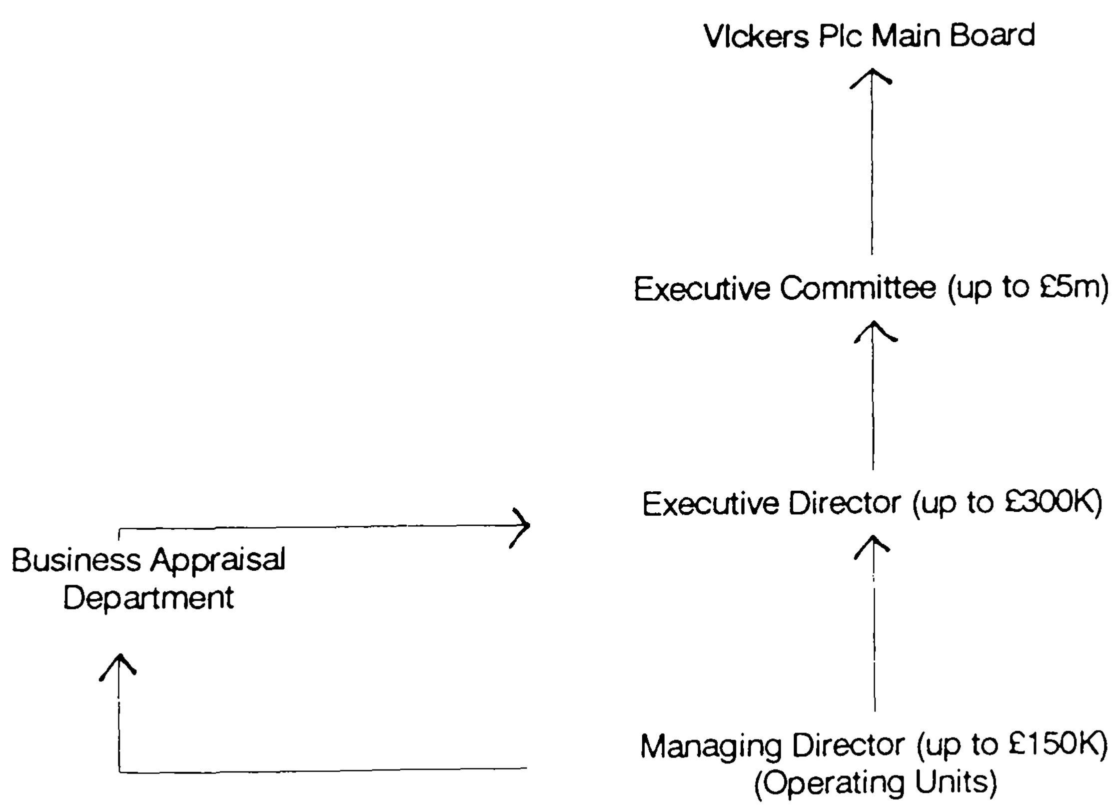
6.5.3 Preparation of the CAR (Jan. to Feb. 1981)

During January and February, Blackmore was working closely with Willis and Hammond on the preparation of the CAR. Hammond recalled:

> "Stuart [Willis] and I provided the figures, Gerald wrote the words."[34]

The formal procedure for the approval of major expenditure were set out in the Vickers Standing Orders and are shown in Figure 6.2 below.

Figure 6.2 Vickers funding approval procedures 1980/81



Note: Figures in brackets were the amounts which could be approved at each level without further – upward – referral.

Projects in excess of £5m had to be approved by the Vickers Main Board. All proposals for major expenditure were to be reviewed by the Business Appraisal Department; Business Appraisal in turn reported directly to the Executive Committee, comprising the executive directors of the Main Board. Main Board approval would be necessary for project Dreadnought - Blackmore had the implicit support of at least one Board member, David Plastow, who had appointed him to VDS.

Willis provided an indication of the more informal process of investment approval on Dreadnought:

> "All the time the project was being pieced together, Blackmore was chatting to Plastow, keeping him informed of what was happening. As main sponsor of the project, Blackmore was sticking his neck out in applying to the Board so he needed to be sure that approval would be granted. He would not have wanted the application to go before the business analysts in Millbank [Business Appraisal Department] without having kept everybody informed of what was going on."[35]

Hammond recalled that Blackmore was also consulting Davey, chief executive of the Engineering Equipment Group (who also had a seat on the Main Board) at that time. Willis was asked about Davey's role:

Interviewer: Would the presence of the Engineering Equipment Group chief executive on the Main Board have reduced the possibility that the CAR might be rejected?

> "In theory his presence on the Main Board could be expected to have helped with final approval. In reality the relationship between David Plastow and Gerald Blackmore was such that Blackmore's proposal was practically certain of success. Plastow expects the chief executives of each division/group to know their business and to take all the necessary decisions in order to progress the business in line with overall company objectives."

Hammond agreed:

> "Plastow appointed Blackmore to do something with Defence Systems, so he could hardly have disapproved of Blackmore's submission."

Both Hammond and Willis were asked whether the approval of the Dreadnought CAR, given the support it had, was a formality. Willis recalled that approval was:

> "..really only a formality, yes, but note that approval was given subject to selective assistance being available from DTI."

And Hammond:

> "...it would have been a surprise if it had been rejected. The downside risk of a new facility was low, however, compared to the existing".[36]

Informants queried about the capital approvals procedure emphasised the importance of informal discussion prior to the formal submission of a CAR. They indicated that the support of higher level managers was important in helping generate impetus, but that Blackmore had already had the support of Plastow, which practically guaranteed approval. The role of top management, in effectively initiating the project - with the appointment of Blackmore - and in supporting Blackmore's application for funding would appear to go beyond the process of 'determination of context' to which they are largely confined in Bower's analysis.

6.5.4 The Dreadnought CAR (Feb to Mar. 1981)

By the end of February (27th) the CAR was ready and was submitted by Blackmore to Davey who presented it to a meeting of the Executive Committee on 10 March. The formal involvement of Business Appraisal is not clear; Hammond, however, indicated that

> "With that kind of support [Davey and Plastow], the proposal effectively bypassed the Business Appraisal Department at Millbank."[37]

The CAR is in two parts: the first is an eight page commercial and financial justification for the capital investment. It reviews the five options available (see above) against a background of the division's financial performance in the preceding decade, and recommends investment in Dreadnought. The second part is a nine page quantity surveyor's cost plan based on an outline design (RIBA Plan of Work stage C). The cost plan contains a construction work programme (1 Page), a floor area analysis (1 page), and an elemental cost summary for the main factory building (2 pages), offices, ancillary buildings and external works (1 page each). The CAR is a confidential document and brief extracts only are presented in Appendix E.2.

The commercial/financial part of the CAR was written in the style of a personal report by Blackmore. In this he briefly reviewed the nature of the AFV business, concluding that the Elswick works could have continued to operate profitably had work been received to a suitable timetable. He continued:

> "However, the real world does not order to a time-table and the influences are very varied - political, financial, international tension, normal replacement - and, therefore, we must consider the future ordering pattern as being variable. The business must be able to stand a double order throughput and also a nil main vehicle throughput for, say, two years."

Blackmore indicated that the loss on a nil vehicle throughput would be some £5m per annum at Elswick; for a new premises, and with the business re-organised along the lines proposed, the annual loss was calculated at between £1.5m and £2m. He concluded:

> "The choice for an ongoing business should, therefore, make the downside acceptable for two years and the upside, while contracts are delivered, rather more attractive than at present."[38]

Hammond's earlier comment that "the downside risk of a new facility was low" is the essence of the financial case Blackmore presented. The savings in operating costs - or, rather, for the 'downside' scenario, the reduction in loss - on a nil vehicle throughput for two years were some £3m-£3.5m per annum. If the business was unable to raise new orders after this, the new facility could be sold at a loss, but the net loss was considerably less than remaining at Elswick. However, the new facility would give the division the capability to respond to a potential 'double order' and with considerably reduced operating costs.

Note however, that the time horizon over which the financial case is made is very short (4 years; to 1985) and that the case is made in terms of net cash flow over the period - there is no mention of return on investment (ROI).

Blackmore's proposed reorganisation of the business had now been clarified. It involved some 430 redundancies; out of a total Defence Systems workforce of 1130 at Elswick, some 700 were to be transferred to the new factory. Willis recalled:

> "The decision as to redundancies - who was staying and who was going - was Blackmore's alone. Once the review had been completed and Blackmore had made up his mind, he never agreed to any changes in the number of redundancies."[39]

Although substantial reductions in the workforce associated with non-production activities were a key element in Blackmore's review, the largely functional structure of the division remained (see figure 6.1 above). However, Blackmore wanted to pursue the strategy of collaborative ventures begun in the 1970s. Hammond recalled that the appointment of David Plastow brought about a more market-orientated approach to Vickers generally:

> "Implicit in the decision to invest in a new facility was the potential for a consideration of the company's product range, which coincided with Plastow's market orientated approach to the Group as a whole."[40]

In the CAR Blackmore hinted at the possibility that the future of the Royal Ordnance Factories may be examined as the traditionally sole supplier of the British Army's tank needs; if this was to happen, he felt that VDS needed to have the capacity to respond to the army's demands[41]. In the event, Vickers acquired the Royal Ordnance tank manufacturing facility at Leeds in 1986 (see Postscript, section 6.8 below).

The CAR indicated a total cash requirement for the project of some £8.9 million, of which some £6.6m was for buildings and works (excluding professional fees). A more detailed breakdown is provided in Appendix E.5. The purchase of the site was not separately budgeted; this was eventually made on a sale and leaseback arrangement with Vickers Properties. Discussions with the DTI had by now indicated that some £3m might be available - a regional development grant of some £1.5m and additional selective assistance of £1.5m - though this had not been confirmed. Willis recalled the DTI's role:

> "The DTI worked very hard to help prepare and process the application for selective assistance. They indicated that it would help the case if we could provide them with extracts from the board papers [CAR]. We went one better and showed them all the paperwork".

Willis noted that after government grants, the net cost of the new factory (excluding redundancy payments) was some £4.5 million. The saving in overheads compared with the Elswick site was some £3 million per annum, giving a "1½ year 'payback' for Dreadnought"[42].

6.5.5 Project approval (Mar. 1981)

The recommendation to invest in Dreadnought was endorsed by the Executive Committee at a meeting on 10 March 1981, less than two weeks after the CAR had been submitted. The meeting minutes note that the committee wished to balance the needs of the Defence Systems division with those elsewhere in the Group. The key deciding factors, however, were the cost savings in moving to the new factory and the substantial contribution from the DTI. Approval was recommended subject to DTI assistance of £3m. Main Board approval was granted on 25 March subject to the same requirement.

Although Blackmore generated considerable support from top management in the preparation and submission of the CAR, they had little or no involvement in the substance of the proposal. Hammond pointed out that:

> "The [five] different options were worked out between Gerald, Stuart and myself as what we perceived to be the way forward."

Interviewer: To what extent were top management involved in this?

> "Not at all."[43]

Willis noted that the Engineering Equipment Group management:

> "..was really only another layer of approval. They did not alter any aspect of the proposal."[44]

This is not inconsistent with the commentary on section 6.5.3 above on the importance of the top management role. It has already been noted that top management were involved in Blackmore's appointment and that they were kept informed of his developing proposals. It is hardly surprising, then, that they did not contribute directly to detailed formulation of the investment proposal nor that they did not alter it following Blackmore's formal submission.

Blackmore was confident that the proposal would be approved and had already appointed Wright Bates as project managers prior to submitting the CAR. His close personal involvement with the project up to that submission was to continue throughout the planning and construction of Dreadnought.

Blackmore's personal dominance of both the definition and impetus processes poses a number of questions for Bower's model as a useful framework for the description of events thus far. Although the initiating, integrating and corporate phases of the processes appear discernible, they do not appear to be spread across the management hierarchy to the extent as implied in the model (nor, indeed, as reported on K2A). The implication is that the integrating-phase task may be, to a large extent, unnecessary here. The role of top management and the proximity of Blackmore - as the main agent of project definition - to them perhaps signals a lack of differentiation between the initiating and corporate level phases of project definition and impetus.

Another proposition arises here. It is that where resource allocation is more of a 'top-down' process, the need for integrating managers in the definition and impetus processes is reduced, compared to where resource allocation is more 'bottom-up'. Although top management did not initiate the Dreadnought project directly, it is very likely that they expected an investment proposal following Blackmore's appointment. Furthermore, the *speed with which Blackmore acted to formulate a proposal served to capitalise on this involvement by maintaining the impetus already provided and, indeed, generating further impetus.*

6.6 PREPARATIONS FOR CONSTRUCTION

6.6.1 Introduction and overview

This section reviews progress with design development in the two months following the submission of the CAR. A small change in facility definition prior to the approval of the CAR is briefly discussed to help examine proposition G (in section 3.4.2) which concerns the extent to which facility definition may be changed without recourse to top management. Particular attention is paid to the arrangements established by Blackmore and Nicholson for project management and for the procurement of construction work which are the subject of propositions H and I.

6.6.2 Procurement strategy and management arrangements (Feb. to Mar. 1981)

Throughout January and February, Blackmore and Nicholson had been developing the outline design for Dreadnought. The intention was to let the building contract under a design and build arrangement; Wright Bates would prepare the outline design as the basis for tender and would, once the contractor was appointed, provide project management services including the preparation of design briefs, site supervision and financial control, etc.

As on the Michell project, Nicholson was keen to retain the control of the outline design of the main building, the detailed design of the M&E services and offices fit-out[45]. Nicholson argued that it made sense to use the contractor's expertise for specific design tasks - such as foundations and structure - which were closely related to speed and economy, but that overall concept and the detailed design of certain elements would be Wright Bates's responsibility. He argued further that this approach offers a number of advantages, including competition for the design and construction of the bulk of the work whilst retaining an element of control over overall concept and the detailed design of key elements.

By 25 February (two days before submission of the CAR), Blackmore had written to Nicholson confirming the appointment of Wright Bates as project managers in accordance with the Outline of Project Management Services which Nicholson had prepared and agreed with Blackmore. Extracts from this outline - which totals 3 pages - are presented in Appendix E.3. The engagement initially covered pre-contract services only, with an escape clause for VDS in the event of the abandonment of the project. The terms of engagement stated that all communication with the contractor concerning the building contract was to be through the project managers.

Blackmore was now involving his production colleagues in more detailed design development: Halroyd as the most senior manufacturing manager available; Carlton in the layout of machinery and production flows; Dawes in programming the machine move from Elswick. Later in the project, other personnel would be involved as appropriate - for the design of office accommodation and stores, for example - and, as the design became more detailed, managers such as Carlton and Dawes assembled teams to deal with their Dreadnought workload. Figure 6.3 overleaf outlines the composition of, and reporting structure for these teams.

Note the overlap of implementation with definition/impetus: Blackmore appointed Wright Bates as project managers - subject, of course to the project progressing - in advance of funding approval. This agreement is specific (for this project) and it delegated considerable authority to Wright Bates to act on Vickers behalf. Although it may be viewed as a temporary form of 'structural context' between Vickers and Wright Bates, it was drafted initially by Wright Bates. In any event, the close working relationship which had been developing between Blackmore and Nicholson up to that point was rather more important than the contractual agreement between them.

Figure 6.3 Dreadnought project structure

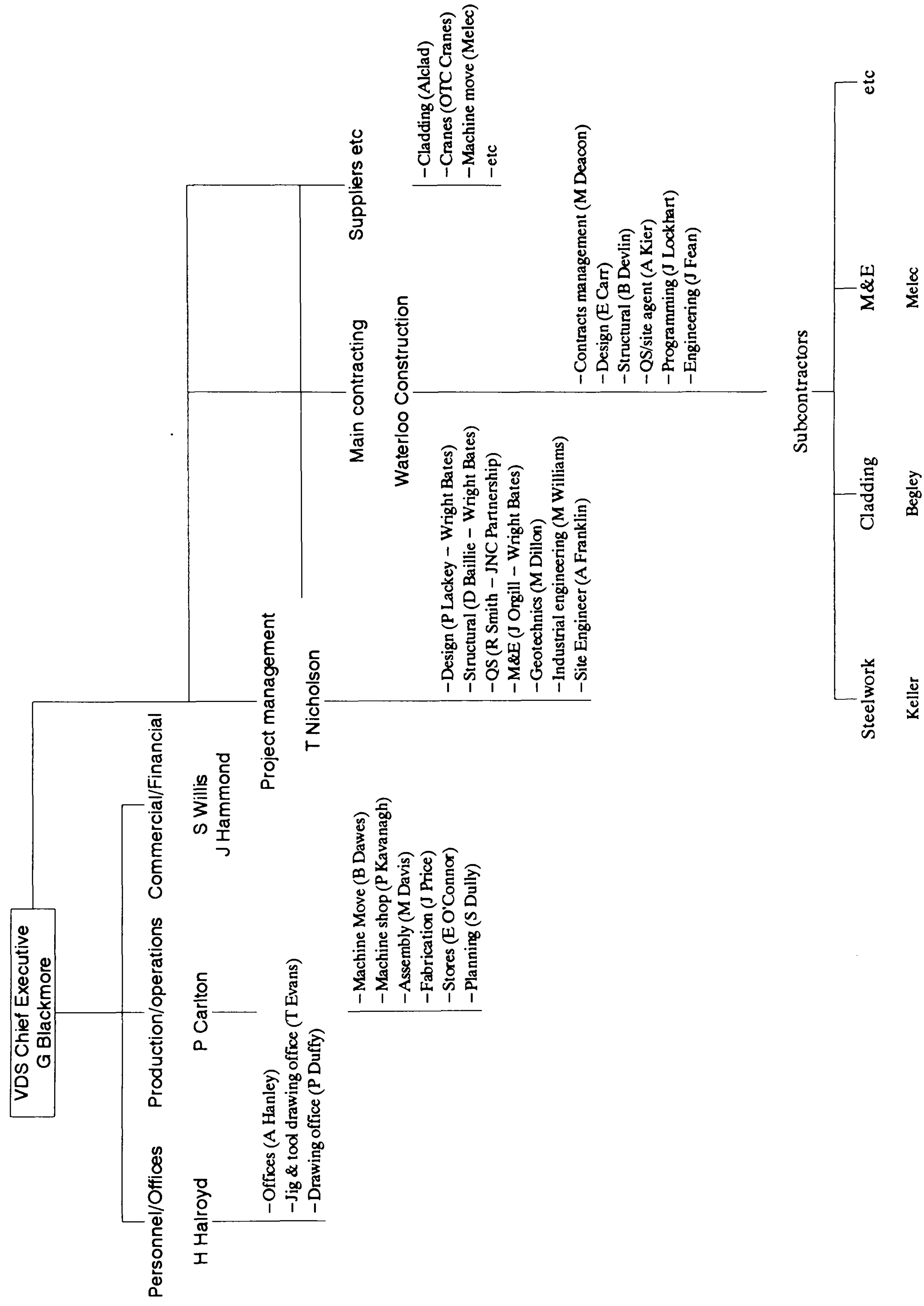


Figure 6.3: Dreadnought project structure

6.6.3 Management of design development (Mar. 1981)

A series of formal project meetings - which were to continue up to the completion of construction on site - commenced on 3 March 1981, 4 days after submission of the CAR by Blackmore. These meetings were the main forum for the identification and discussion of detailed VDS requirements and were held on average once or twice every week. They were attended by Blackmore up to the commencement of construction work and less frequently thereafter; most were attended by Nicholson. Blackmore and Nicholson remained in close and regular contact outside of these formal meetings.

Nicholson wanted the early stages of design development to focus on issues critical to the overall programme. He identified the design of heavy machine bases and the appointment of a crane supplier as matters to be resolved as early as possible. By the first project meeting Wright Bates had already appointed a soil investigation consultant and Nicholson was keen to have data on ground conditions from the soil investigation and on machine loadings from Vickers to include this in the tender documentation for contractors who would be asked to design the machine bases. He was also keen that a crane supplier be selected prior to letting the main construction contract. This would enable tendering contractors to determine crane installation and accommodation requirements[47].

At that first project meeting Nicholson elaborated on the outline procurement strategy agreed with Blackmore some weeks earlier. Expressions of interest were to be invited from up to 10 contractors to form a selective tender list of 4. Nicholson suggested using the 'new' JCT Standard Form of Building Contract (Contractor's design option) and agreed to pass a copy to Vickers's legal department for approval.

6.6.4 Overall project programme (Mar. 1981)

The first project meeting noted that Blackmore favoured a start on site of 24 July 1981. The programme discussed was that contained in the CAR (see extracts in Appendix E.2). This required that the design brief would be 'frozen' in February 1981 - although it was clear that the design would have to be developed considerably from that represented by the CAR cost plan, no major changes to the scope of the building were envisaged. Hammond recalled:

> "In principle, all we were getting was a shed. Once we had decided on the overall size and shape, the only arguments were over what space within the given envelope was assigned to each function. There was no arguing that the envelope was not big enough, because Gerald [Blackmore] just decided; 'Thats the size of it'. The overriding philosophy was that 'There will be no changes', so nobody asked the question."

In any event the new factory was sized to accommodate large variations in throughput and both Hammond and Willis felt that the building could be extended or a new building built relatively quickly. Hammond noted:

> "We felt the factory could be extended linearly if needed. The land next door was purchased in case we had to do this."[48]

To complete construction work within the one year 'Dreadnought' timescale, Nicholson drew up a project programme indicating that work would commence on site in July 1981 and would be completed by July 1982.

The possibility that change may be required to the size of the building as defined in the CAR was effectively precluded by Blackmore, first in his sizing of the building to accommodate an unprecedented throughput, and secondly, in his determination to complete construction work within the one year 'Dreadnought' timescale.

Once the size and structure of the workforce and production systems had been determined and the site selected, the problem of definition for facility-oriented managers (like Carlton in particular) was not a matter of whether enough space was available, but how to accommodate the necessary processes within the pre-determined space.

6.6.5 Changes to the office accommodation (Mar. 1981)

Blackmore had intended to construct a new production facility only; some 4000 square metres of office accommodation was to be provided in freestanding 'Portakabin' units linked to the main production building.

The cost plan in the CAR which went to the Executive Committee on 27 February incorporated this proposal, and it featured in the Outline of Project Management Services sent to Wright Bates on 25 February.

Nicholson, however, was unhappy with this proposal. He felt it was architecturally unsatisfactory; furthermore, it would divorce the production workforce from their administrative colleagues. He recalled:

> "Right from the beginning, Gerry said that there was no money for office accommodation. In retrospect, I think he was just winding me up. He had allocated about £1m for Portakabins. We played on his views of unity of the workforce; that it was logical to extend the factory to provide office accommodation, that accounts, drawing office, etc, were all part of the operation of building tanks. We also said that offices would be a minimum upgrading of the basic shed to keep the costs within the original budget for Portakabins. He jumped at this. So we had a £1m budget for offices; I think in the end this worked out at a bit more."[49]

Nicholson proposed extending part of the roof along the line of the main portal frame to provide 'lean-to' office accommodation (see Appendix E.1). Jones modified the cost plan and concluded that, although the integral offices would be more costly than Portakabins, they could be obtained within the overall construction budget. Blackmore agreed to the change and the revised cost plan was substituted for that in the CAR prior to the Executive Committee meeting on 10 March. Wright Bates agreed to design the offices in outline and the fit-out work in full (their terms of engagement and fee were subsequently altered). The main contractor would design the offices structure in full to Wright Bates's outline design (as for the main production area).

The source of redefinition in respect of the office accommodation lies in a discrepancy ('quality - of accommodation - is inadequate') identified by Nicholson. Although the argument contains statements about the benefits of integrating the workforce, the case on which a decision is requested - as in the case of Blackmore's investment proposal to the Executive Committee - is made in financial terms.

6.6.6 Design of heavy machine bases (Mar. to Apr. 1981)

The main focus of project meetings in March was the location and design of machine bases. There were a total of 357 machines to be moved from Elswick. The location of the machines requiring extensive foundations was concerning Nicholson who expected - from his involvement in the Michell factory on the adjacent site (see section 6.4.2 above) - that ground conditions would be poor. Nicholson recalled:

> "There were 30 or so big machines (some of these weigh as much as 250-300 tonnes) at Elswick. Almost all of these had piled foundations, but these had been acquired over a 40 or 50 year period, at a maximum rate of about 2 per year. The cost of doing this all at once would have killed the job."[50]

Nicholson reckoned that the design of foundations and heavy machine bases would be the contractor's main design problem. He wanted to provide as much information on the location and operating criteria of the large machines as available to the tendering contractors to eliminate as much uncertainty as possible from tenders submitted. However, many of these machines were old and records of their existing foundations did not exist. Additionally, it was not possible at this early stage in the design to determine the precise location of machines as the production layout had not been finalised.

At the 23 April project meeting Blackmore indicated that he was interested in how the risk of machine base design would be allocated. He was particularly interested in the trade-off which could be identified between the costs of being certain that no adverse settlement occurred in all machine bases and the likelihood of future settlement causing a disruption to production. Although it would appear that no formal risk analysis was undertaken, the approach taken reflects Blackmore's concern to place as much of the responsibility as possible for machine base design onto tendering contractors.

Wright Bates were, at that time, preparing the Employer's requirements for issue to tendering contractors by 15 May. Analysis by Nicholson and Carlton had indicated that for 2 of the 30 heavy machines, settlement could be accommodated only within the limits of their built in jacks (which had a maximum range of ± 6mm) Settlement outside of this range would not be acceptable as the machine would require to be rebedded and this could seriously disrupt production. The design criteria in respect of these machines could be clearly stated and the contractors asked to make appropriate provision. Settlement tolerances were not so fine for the remaining heavy machines. For these, settlement outside of the ± 6mm range could be accommodated up to 25mm by repacking with steel shims. Instead of stating rigid criteria in respect of these latter machines - which Blackmore felt would have proven costly to satisfy - the approach was to invite contractors' design proposals which would be evaluated on the basis of how the risk of settlement appeared to be allocated. The Employer's requirements state:

> "The Employer is anxious to obtain an economical solution to this problem and to this end has avoided laying down tolerances for settlement which are difficult to achieve in building terms. The Contractor's design solutions will be evaluated on a basis of value for money; first cost balanced against acceptable risk of settlement. To enable this to be correctly assessed it is essential that the Contractor states... predictions of the likely performance of each base or group of bases under fully loaded conditions."[51]

Many of the practical problems of building the new facility on this site had to be addressed early in the facility definition process because of the tight timescale imposed by Blackmore. In particular, the need for machine base criteria to be issued to tendering contractors before the factory layout had been decided complicated the issue of machine base design. Further, although Blackmore's apparent need for cost and risk minimisation is hardly surprising, it is important to note how his interest in the risk/trade-off equation was given expression in the specification and made an element of the competitive tendering process. Although proposition I concerns the extent to which construction clients may determine a form of structural context between the firm and construction firms to enable change to be managed, Blackmore appears to have been able to 'determine context' for a very different reason.

6.6.7 Definition of accommodation requirements (Apr. 1981)

Although the main focus of project meetings was on the definition of design criteria for machine bases up to the end of March 1981, throughout April design development was broadened to consider the definition of office requirements, materials storage and ancillary building requirements.

More VDS personnel were becoming involved as the accommodation needs of different aspects of the business in the new factory were considered in detail. Part of Blackmore's review considered which operations were to be retained, which were to be closed down and which were to be contracted-out. Although this had largely affected administrative and support functions (see above), Carlton and his colleagues also considered which production operations were necessary and what improvements could be made. He recalled the process:

> "We took the opportunity to provide shot blasting at Scotswood Road. Also, we had to decide whether to subcontract or keep in-house certain technical processes. A strong case was made [to Blackmore] to keep the phosphating process. Generally, a case would be made and submitted to Blackmore. Blackmore and Nicholson would then arbitrate."[52]

Note that detailed preparations for construction and design development were progressing prior to funding approval by the Executive Committee on 10 March. The definition process was now involving additional Vickers's personnel, but note the authority of Blackmore and Nicholson as 'arbitrators' as to what could be accommodated. Nicholson's early attention to the problem of heavy machine bases is indicative of his understanding of the need to keep project costs within the limit established in the CAR.

By the end of April VDS had clarified their requirements as to ancillary accommodation. Wright Bates were proposing to accommodate some of the ancillary buildings in a subsidiary bay flanking the northern side-bay of the main production building (see Appendix E.1). The CAR cost plan had envisaged a number of small separate ancillary buildings.

The extent of offices required and their location was also clarified around this time. Some 3300 square metres of offices were to be provided on two floors to the south side of the main production building.

6.6.8 Site preparation

During April Blackmore was in regular contact with Best, Vickers Properties manager involved in letting the demolition contract on the Scotswood Road site and was keen that demolition and preparation for construction be co-ordinated. He was particularly concerned that the damages for late completion in the draft contract for demolition works (which Best had forwarded to him) did not reflect the significance of delay:

> "Very brief reading of the demolisher's contract indicates that time does not appear to be of the essence, but the cost penalty to Vickers Limited of delays in proceeding are very substantial and could approach a figure as high as £0.25m per month."

Blackmore went on to confirm that "the critical date" for handing over a cleared site to the contractor was 24 July 1981. He noted these dates and the financial importance of the overall project timescale "in case you feel that the contract with the demolisher needs amending" and concluded:

> "I should be grateful if you would confirm that there is no risk, either on time scale or contract definition, from meeting our site requirements."[53]

Note Blackmore's preoccupation with the project timescale - his position and authority allow him to make comments on the demolition contract to which he is not a party - and his expression of the effects of not adhering to this in financial terms. The previously calculated saving in operating costs (£3m per annum) equates to £0.25m per month.

6.7 GETTING DREADNOUGHT BUILT

6.7.1 Introduction and overview

Throughout the tender period and following the commencement of construction operations on site, a considerable amount of detailed design development work was undertaken. Additionally, the management of the construction process was not without incident. However, there were none of the major changes which characterised Glaxo's K2A project. It is not the intention here to document all of this design development nor project management in any detail. Rather, attention is paid to the extent to which VDS ensured that facility definition progressed within the funding limit established by top management approval of the CAR, so that proposition H (in section 3.4.2) may be addressed. Although the management and procurement arrangements are reviewed briefly in section 6.6 above, more detailed consideration is given here to how the 'structural context' between VDS and construction firms was determined to facilitate (or discourage) change. This is the subject of proposition I.

6.7.2 Procurement of key components and material (Apr. to May 1981)

Several separate orders were placed by VDS for the supply and installation of specialist components and materials. Two of these - the overhead cranes and the wall and roof cladding - were seen as having a potentially significant impact on the project programme. Nicholson was keen to place an order for overhead cranes prior to the appointment of the main contractor (see above), as details of the chosen manufacturer's requirements would need to be made known to tendering contractors to enable them to assess the impact on their design proposals. Early in May Wright Bates together with Willis and manufacturing colleagues from VDS met each of the three crane suppliers who had submitted tenders to resolve technical details and to obtain final quotations. Blackmore requested Willis's presence so that an assessment of the supplier's current trading position and financial soundness could be made. By the end of May OTC Cranes had been selected and an order placed with them.

Given the extent of wall and roof cladding - a total area of some 43,000 square metres - both Blackmore and Nicholson were concerned about the need to pre-order to ensure that the large quantities could be manufactured in time and that no disruption to the building programme would result from delays in the supply of materials. Blackmore, in particular, was keen to use the buying power of such a large order to obtain a favourable discount. The tenders issued by Wright Bates to three suppliers early in April for the supply only of cladding material were returned by mid-May. Blackmore quickly established that further discounts off the quoted amounts were available. The 22 May project meeting was informed that he had reached an agreement with Alclad's managing director at a meeting the previous day for the supply of cladding.

6.7.3 Procurement of main construction work (Apr. to Jul. 1981)

Towards the end of April Nicholson had drawn up a shortlist of five contractors from which Blackmore requested details of published accounts and recent workload. Willis reviewed this material and wrote to Blackmore concluding that all of the companies had the capability to undertake the work but wondered whether the more successful financially might be the most appropriate choice as:

> "...their success may have been gained at the expense of their customers."[54].

In their paper on Selective Design Allocation, Wright Nicholson Partnership recall that:

> "It had been a major requirement in the prior selection of the final list of contractors invited to compete for this project that they had the necessary design capacity to deal with the programme of detailed structural design within the extremely tight programme."[55]

Tender documentation was finalised in early May. Vickers's legal department were satisfied with the proposed form of contract (JCT Standard Form of Building Contract with Contractor's Design 1981); this project was one of the first - and the largest - up to that time to be let on this form. Blackmore was keen to stress the construction timescale and he demanded a level of liquidated and ascertained damages which would reflect the loss to VDS of delays to the completion of the works:

£25,000 per week for the first four weeks
£50,000 per week for the next four weeks
£75,000 per week for remaining weeks

The Employer's Requirements formed a key component of the tender documentation and contained a description of design responsibility which was summarised in tabular form (see Appendix E.4). The importance of detailed design development was emphasised:

> "The successful contractor's design team will need to work in close collaboration with the employer and his agents in the development of the detailed design to ensure that the design intention is achieved."[56]

The VDS approach to procurement may be contrasted with Glaxo's on K2A. On K2A the emphasis was on negotiation to 'buy' co-operation in the event of change and disruption. On Dreadnought there was an emphasis on the allocation of risk to tendering contractors in respect of those aspects of the work which could not be clearly defined in advance. This contrast is examined further in the next chapter.

Although some consideration was given (by Vickers's legal department) to the contract form proposed, this did not result in any project-specific requirements and the extent to which the proposed contract documentation was designed to determine a unique form of 'structural context' between Vickers and the main contractor was limited. More significant was the level of liquidated and ascertained damages determined by Blackmore to help ensure that the project timescale and budget was adhered to. Wright Bates's (complementary) preoccupation with the design capability of main contractors as a factor in their selection was also relevant to help ensure compliance with the project timescale and cost, as was Willis's financial 'vetting' of potential sub-contractors and contractors.

Following the issue of tenders on 18 May, Nicholson was keen to complete the outline design before appointing a main contractor. However, a number of problems remained to be resolved by the time tenders were returned on 13 July. The layout of heavy machinery in particular had not been determined and this in turn was delaying the finalisation of the layout of the ancillaries accommodation. At the 24 June project meeting it was agreed that both the location of a small number of large machine tools and a programme for their installation could not be finalised until after a contractor had been appointed and VDS had the opportunity to review his proposals for location of large machine bases in particular[57].

A project meeting was held on 13 July 1981 to review returned tenders. All five tenders exceeded the cost plan figure of £6.6m. All but one of the tenderers submitted detailed written proposals for the design of foundations and structure in particular, including method statements for site operations. Four tenderers were asked to propose reductions to the CAR cost plan figure of £6.6m. The tenderers' reductions - mainly concerned with substructure and external services - were appraised by Wright Bates in the light of their proposals for foundation design in particular. In these terms, the tender submitted by Waterloo Construction, although one of the highest, was considered to provide the greatest scope for cost reductions whilst retaining acceptable proposals for foundation design. Further reductions were suggested by VDS and Wright Bates and concentrated on the external works elements and on tank testing facilities external to the main factory. The approach was partly to 'wait and see' what funds would be left over on completion of the main construction works; this was confirmed at the 12 August project meeting:

> "Project Managers referred to pre-contract discussions and stated that the external works were to be subject to an overall review, in which the effects of cost reductions could be properly appreciated only by consideration of a revised outline layout in relation to the opportunities presented by the site. This would be a collaborative exercise between the Project Managers and Waterloo Construction."[58]

On 31 July, agreement was reached with Waterloo Construction and a contract signed for the sum of £5.94m. Total reductions from the tender sum of some £1.3m had been agreed, comprising contractor's reductions of some £0.8m and reductions in provisional sums of some £0.5m (see breakdown, Appendix E.5). The date for possession of the site was agreed as 3 August; the date for completion was 30 July 1982. Blackmore proposed that a £40,000 bonus would be paid for completion one week earlier than the agreed date.

6.7.4 Management arrangements - programme and cost control (Jul to Aug. 1981)

Once a project budget had been determined and approved by the Executive Committee, Blackmore was keen to ensure that changes could not be introduced which would disrupt the construction programme and incur higher costs. Willis recalled:

> "Although Blackmore had the final authority, within the overall cost of the project, the cost could not be exceeded without the prior approval of the Board."[59]

Although Nicholson wanted to resolve as much of the outline design as possible prior to the appointment of a main contractor, the tight timescale meant that the definition of VDS's needs paralleled - to a substantial degree - the process of building construction. Nicholson insisted that all instructions to the contractors would be issued through Wright Bates (see 6.6.2 above). Hammond recalled that:

> "Only two [VDS] people ever dealt directly with the builders or the architects - Blackmore and Willis. No one else had any authority to make changes."[60]

Project meetings continued as the main mechanism for design development involving both Wright Bates's and Waterloo Construction's designers. Less than two weeks into the contract, at the 12 August project meeting, Nicholson confirmed the proposed arrangements for cost control which had been worked out and agreed with Blackmore:

> "Project Managers emphasised that close cost control was to be exercised ... To achieve this would require some discipline, particularly as the design was still to be developed in many respects from the Employer's Requirements. The Project Managers would regard the development of Employer's Requirements as involving no cost implications, provided that no new requirements were introduced. If at any point the contractor believed that new requirements were being introduced ...then it was up to him to speak up."[61]

Nicholson requested that the cost implications of all instructions to the contractors - called Employer's Instructions (EIs)[62] - were to be assessed <u>and</u> agreed prior to issue. However, Waterloo Construction were concerned about these arrangements. Deacon, the contracts manager on Dreadnought, noted that:

> "In his view it would be difficult if not impossible to achieve this degree of cost control in a contract of this size and speed."[63]

Nicholson enlisted Blackmore's help to confirm the cost control arrangements at a special project meeting a week later. Blackmore confirmed that VDS needed to know in advance the size of any financial commitment it undertook. He reaffirmed the requirement for 'close' cost control in line with the procedure outlined by Nicholson at the 12 August meeting. However, the minutes of later project meetings note Waterloo Construction's continuing unease concerning the workability of these arrangements (see below).

Arrangements for programme monitoring were also outlined by Nicholson at the 12 August meeting. The minutes record that separate progress meetings dealing with quality control were to be held; however, these were eventually absorbed into site progress meetings. Willis summarised the arrangements:

> "Blackmore visited the site every day, and met with Ted Nicholson and the resident engineers. These were informal meetings and were not minuted. 'Progress checks' [see below] were held 3 times per week and minuted. Formal progress meetings were held every 3 weeks. Project meetings were held up to twice every week."[64]

By the second progress meeting on 22 September, Waterloo Construction again voiced their concern about cost control procedures and the requirement for the final pricing of all variations in advance of work being authorised:

> "Mr Deacon...considered that the insistence on the close pricing of variations at this stage in the project was likely to divert the energies of his site staff from the essential objective."

Deacon argued that the issue of EIs requiring an immediate response could be costly and involve the establishment of a site team specifically to deal with these matters. In reply,:

> "Mr Nicholson said that Vickers already understood that it was necessary to regard the main shell of the building as if it were an existing building, and to save any changes until after completion. But he could not agree with the deferment of cost settlements until the end of the contract, these must be swept up as the contract proceeded."[65]

Nicholson was making a distinction here between substantial changes to the Employer's requirements which could be dealt with following completion of the contract, and necessary changes which could only be made during the progress of the works.

It is hardly surprising that project management and control procedures may be created to assist client objectives concerning time and cost. However, the project management and cost control procedures Nicholson had devised were an important mechanism enabling resource allocation to take place during the construction phase. Although it would appear that resources had already been allocated, in that the quantum of funding available had been determined, there remained the task of allocating this available funding across the different accommodation needs of the business as the design developed. This required information on what was practically and financially achievable; more than that, it needed a mechanism whereby the 'client' could intervene in the construction process if necessary. The observation of interest here is that mechanisms for information (cost reporting - see below) and intervention (EIs) were explicitly related to the ongoing process of resource allocation. This form of 'structural context' was under the control of the client: note the invocation by Nicholson of Blackmore as higher authority to insist that the management and control procedures proposed be adopted despite the contractor's disquiet.

Nicholson's 'existing building' analogy is a reminder that no major change to the scope of the building was envisaged. The minuted exchange between Deacon and Nicholson is indicative of much of the formal meeting minutes relating to project and progress meetings. These minutes were prepared by Wright Bates and, on issues of dispute, have a tendency to outline the contractual position or to attempt to speak on behalf of VDS.

The VDS cost reporting procedures are discussed very briefly because they were the subject of some discussion and criticism in a subsequent financial review of Dreadnought. Beginning on 21 August 1981, Willis established a monthly cost reporting format which he and Hammond maintained throughout the duration of the project. This was based on the quantity surveyor's monthly cost reports. The VDS reports sought to compare actual and anticipated expenditure with what was authorised by the Board (the format of the summary is shown in Appendix E.6).

As work covered by provisional sums was carried out it was measured and priced by the quantity surveyor and agreed with the contractor. However, the reporting convention - which was not unusual for this type of contract - was to omit the provisional sum in total and to add the value or forecast value of the relevant EI. As the project progressed and the number of EIs accumulated - a total of 350 were eventually issued - it became increasingly difficult to identify the source of cost changes without considerable cross referencing to the quantity surveyor's detailed records on which the reports were based. This was because some of the EIs related to work under more than one provisional sum, while others related to a single provisional sum.

6.7.5 Early delay and the avoidance of potential claims (Aug. to Dec. 1981)

The design and construction of machine bases was, as Nicholson had anticipated, not to proceed without incident. As early as 13 August, Deacon had written to Wright Bates starting a detailed and protracted dispute. Waterloo Construction's contention - disputed by VDS and Wright Bates - was that delay in the finalisation of machine base layout by VDS had involved Waterloo Construction in abortive design and construction work. While the intention here is not to adjudicate over this dispute, the role of VDS - and Blackmore in particular - is of particular interest in a consideration of the study proposition (H) concerning how the process of facility definition was managed to help ensure that the building required was obtained within the funding limit available.

Nicholson wrote a lengthy reply to Deacon's letter of 13 August rejecting the basis of the claim and convening a meeting between VDS, Wright Bates and Waterloo Construction on 19 August in Blackmore's office. Nicholson knew that he had a powerful ally in Blackmore:

> "I kept very close to Gerald Blackmore throughout all this. I copied all the correspondence to him."[66]

and that Blackmore's firmness of purpose not to exceed the project budget and not to enter into unknown financial commitments would be difficult to overcome. However, exchanges of correspondence between Waterloo Construction and Wright Bates during September and October indicate ongoing disputes about the delivery of information for machine base design and changes of mind by VDS. Nicholson, in turn, noted that Wright Bates had become more involved in checking Waterloo Construction's machine base drawings following a series of drafting errors (which Nicholson attributed to a recent increase in Waterloo Construction's drawing office staff to cope with the increased workload).

Nicholson and Blackmore instigated a series of 'claims meetings' - concerning, *inter alia,* machine base problems - to resolve and agree outstanding claims rather than to let these accumulate into unknown problems at the end of the contract. Three meetings were held between VDS, Wright Bates and Waterloo Construction between November and December 1981 to examine the contractor's claims concerning machine base design and construction. By the second meeting the minutes make clear that there was still no resolution of the dispute:

> "There was a wide ranging discussion of the whole matter of claims by Waterloo Construction, and it was mutually agreed that there would be little value in attempting a full minute of this part of the meeting. Essentially, the discussion consisted of a vigorous complaint by Mr. Blackmore and Project Managers that Waterloo Construction were raising an inordinate number of claims... Waterloo Construction strenuously denied these allegations, and Mr Deacon stated that in his view the matters at issue should be settled by the professionals, and should not involve the client as in the case of this meeting."[67]

However, Blackmore - as client - was to have a key role in the final claims meeting on 17 December. Although the minutes are brief, referring only to an "exhaustive discussion", Nicholson recalled that:

> "Gerald opened the meeting by saying that the claims being discussed - and the prospect of further cost increases due to claims not yet made - would kill the job. He had got as much money as there was available from the Board; there was simply no more left."[68]

Subsequent correspondence between Waterloo Construction and Wright Bates confirm that, with the exception of specific claims for additional drawing office time (and for delays relating to the supply of gutter sections by VDS - see below) - which Wright Bates would examine - all other claims would be withdrawn.

Shortly following the onset of this dispute, Nicholson recalled that he instigated 'progress checks', 3 times per week. Project records show that these commenced on 2 December 1981 and continued until June 1982. Nicholson met with Waterloo Construction's site quantity surveyor - Kier - to identify the causes of any delay and to reduce the likelihood of claims arising. There were handwritten notes of these meetings though no formal minutes were issued.

Blackmore's intervention again - as in the establishment of management and cost control procedures (see commentary on section 6.7.4 above) - was critical in ensuring that the need to keep costs within budget was met. This was achieved by a combination of authority and threat; despite Nicholson's considerable authority to act on Vickers's behalf in dealing with the contractor, these weapons were not available to him. Note that Blackmore also invoked a higher authority - the Vickers Main Board - to say that no more funding was available.

Nicholson acted to adjust 'structural context' in an attempt to avoid subsequent disputes. Note that these aspects of 'context' - meeting arrangements and the like - did not require contractual alterations and were, in this case, capable of being determined by Nicholson, the client's agent.

6.7.6 Overall progress and the involvement of VDS in construction (Oct. 1981 to Jan. 1982)

By October the layout of heavy machines had been finalised. Carlton recalled that the pace of construction had forced him to compromise on layout:

> "The final production sequence was not as neat as originally conceived, but decisions were needed quickly to enable the design and casting of machine bases to proceed. The heavy part of the shop was ironed out first. The plant layout was developed with Wright Bates and Waterloo Construction alongside the construction work. They were forcing the pace here, looking for decisions."[69]

As the project progressed, there is an increasing focus on detailed design development and on the co-ordination of subcontractors which Nicholson felt was critical to achieve the overall programme. Although Blackmore remained in close contact with Nicholson in particular throughout the period of work on site, day-to-day project management was handled by Nicholson. In addition to contributing to design development, VDS and Blackmore were also involved in the procurement of components and material, the fabrication of items for incorporation into the works and the movement of machine tools from Elswick.

The overhead cranes and cladding were the most significant items purchased directly by VDS (see section 6.7.2 above). A number of smaller items were fabricated by VDS and supplied to the contractor. This was done partly as a cost saving measure and partly because during 1981 the VDS fabrication shop was short of work. Nicholson recalled:

> "During the project, Vickers had very little work on. There were a number of items which we felt they could do easily. Basically, anything that could be made from 6mm plate steel was looked at. We were being quite radical here; most of the ancillary buildings - the gatehouse, the suppression chamber, and so on - were made from steel plate."[70]

One of these items was a gutter to the north - roadside - face of the building and which Wright Bates decided to fix in a combination of horizontal and raking sections as an architectural feature. This gutter weighed over 70 tonnes and the structural frame had to be designed to accommodate it. The Steelwork subcontractor - Keller - was responsible for designing and detailing the gutter for fabrication by VDS. A dispute arose concerning the delivery of design information and the eventual delivery to site of the gutter. Although this dispute was largely resolved at the 17 December claims meeting (see section 6.7.5 above), a further problem was that sections of gutter had to be returned by Keller who were unhappy with the:

> "suitability of... the gutter for erection in the context of building construction."[71]

Modifications were carried out at VDS's expense to provide adequate tolerances for fixing, but this extra work tended to reduce the cost saving which was expected from having the work done by VDS in the first place. However, Nicholson recalled that the involvement of the line workforce in the project was one way in which Blackmore obtained their support:

> "It is important to remember that when Gerry took over, nobody believed that Dreadnought would happen. They all thought it was just a 'blind' to close down the business. There was profound suspicion, particularly from the shopfloor workforce, about his plans".[72]

Nicholson recalled an "enormous fund of old-fashioned Geordie goodwill" among the workforce who were involved in the manufacture of gutters and other items which included a number of external buildings - the main gatehouse, gas meter housings, paint store, etc - and a range of railings, fencing and canopies. However, Willis recalled that VDS took longer to produce these items than was intended. Additionally, the work was eventually charged to the contract on the basis of time spent at enhanced overhead charges and, though the delays involved did not materially affect construction progress generally, the final cost was some £500,000 compared to an allowance of some £200,000 in the original tender amount.

By December 1981, VDS had negotiated a contract with Melec Ltd (who were Waterloo Construction's mechanical and electrical installation subcontractors on Dreadnought) for the relocation of production machinery.

By this stage the Nigerian order - some £45m (1981 prices) - had been confirmed. A meeting called by Nicholson in January confirmed the programme for the move, beginning on 1 May 1982, for which the overhead cranes were required to be operational and the heavy machine bases were to be completed. Nicholson confirmed that all communications from VDS or their direct contractors were "to go through" Wright Bates. He proposed that Melec Ltd and the VDS personnel responsible for the machine move would attend progress meetings up to the time of the machine move[73]. Carlton recalled the machine move:

> "The timing of the move was critical: there was an 'order window' between the two 'African orders'[Kenya and Nigeria]. Bill Dawes [Works Engineer] programmed the move. This was a very complex operation. Machines were dismantled and moved with respect to their relevance to production requirements for the two main orders. Blackmore monitored this daily".[74]

Severe weather during December 1981 and January 1982 delayed progress on concreting and steelwork especially. Although all the major building elements were in progress at that time - machine bases, floor slab, steelwork and cladding - the steelwork had been most affected and was some 4 weeks behind programme by the end of January 1982. The machine move depended critically on the completion of the structural frame. Blackmore offered Waterloo Construction a bonus of £30,000 to regain the programme in time for the commencement of the machine move on 1 May as planned. Although the overall completion date was revised (to 27 August because of the inclement weather) completion of the frame and machine bases enabled to machine move to commence on 1 May as planned.

Blackmore's 'intervention' in the construction process has already been noted in respect of the imposition of management and control arrangements and the resolution of potential contractor's claims. These interventions may be termed 'critical' in that Blackmore's power and authority were required to clear an impasse which could not be resolved by either Nicholson or any of the other of Vickers's personnel involved. The offer of a bonus to the main contractor to regain time lost due to inclement weather was also in this 'critical' category.

But Blackmore - and VDS - participated more in 'routine' construction matters less related to crises requiring authoritative intervention. This involvement was not limited to what might normally be expected of a construction client on this kind of design and build contract. In particular, a number of key materials and components were either purchased directly or manufactured by VDS for incorporation into the works by the contractor. Although it would be reasonable to expect VDS's direct involvement in the purchase of overhead and jib cranes and in the arrangements for the machine tool move, the same cannot be said of their direct purchase of cladding. This latter purchase is understandable, but the rationale - unlike the purchase of cranes and the machine move - had little to do with their detailed knowledge of production needs.

Of more interest here, however, is the use of spare manufacturing capacity to supply components to the works. Although ostensibly a cost-saving measure, this did little to reduce costs but its effect on involving the workforce directly in the project should not be missed. Nicholson spoke of the "fund of Geordie goodwill" which he believes his team tapped; Blackmore in the CAR wrote about his concern to avoid a "rearguard action by the workforce" to thwart his plans. This is important; the level in the firm's hierarchy at which this project originated meant that, as well as securing top management funding approval, Blackmore needed to secure the 'approval' of the VDS management and workforce if the project was to proceed. Although the VDS management were involved in preparations for the move from Elswick, the line workforce were largely excluded.

In summary, the extent of VDS involvement in the construction process - all channelled through Blackmore - was considerable. This involvement included detailed decisions about layout and the provision of machine data for foundation design, for example, as well as pre-ordering key components and materials to fit into the contractor's construction programme, manufacture of items for incorporation into the works and critical decisions regarding the implementation of management procedures and the resolution of contractor's potential claims.

The VDS financial report of January 1982 provides the first indication of the possibility that the budget might be exceeded, with a forecast expenditure of some £7.8m against an authorised total of £7.5m (see Appendix E.6). Although the provisional sums in the contract had been almost halved (from £1.33m to £0.68m), the value of EIs and work carried out directly by VDS had more than exceeded this reduction. The forecast increase was not substantial, however. Nevertheless, Willis wrote to Ray Ewright (Engineering Equipment Group Commercial Director) at the beginning of February with a notification of this increase and indicating a project final cost of £7.83m, including the £30,000 'bad weather bonus', against an authorisation of £7.5m.

The VDS financial reports show escalating project costs up to April 1982[75] (see Appendix E.6). These were due largely to the addition or expansion of a number of facilities not originally envisaged, for example, the addition of a presentation suite in the office accommodation. The closing weeks of the contract were characterised by an accelerated programme of relatively minor works as both Waterloo Construction and VDS - who were fabricating a number of the external structures and facilities - hurried to complete by 20 August. Nicholson issued the certificate of practical completion on 31 August. Following a site meeting on that day, Blackmore wrote to Waterloo Construction confirming that the effective contractual completion date was 20 August. He confirmed that the final account would be agreed within the terms and rates contained in the contract, and that:

> "It is agreed by Waterloo Construction that they have no outstanding claims against Vickers for loss and expense caused by disruption of the regular progress of the works."[76]

No liquidated and ascertained damages were invoked and there were no formal claims for loss and expense by Waterloo Construction. Blackmore was keen to agree the final account in time for the official opening on 24 November, and by mid-November 1982 Jones had prepared a draft final account in the sum of £6,198,000 which was £260,000 (4 per cent) more than the contract sum. The main causes of the overspend were unforeseen substructure work (underground obstructions; £80,000) and offices fit-out, including presentation suite (£93,000 greater than the initial estimate). The final account of £6,275,000 was agreed at a meeting on 19 November 1982.

6.7.8 Financial review

By November 1982 the extent of the overspend was becoming clearer as not only was the final account being drafted, the extent of VDS involvement in the fabrication of contract items was also clarified and quantified. On 1 October Willis sent a telex to Ewright indicating that costs had increased and noting the difficulty in identifying the causes:

> "Up to 22nd September 1982 we have had 348 amendments to the contract, some resulting in increases and some in decreases to the total cost."[77]

By 15 November Willis had submitted a formal authorisation request to the Executive Committee, indicating that the overspend, on an 'incremental basis' had been limited to £155,000[78]. This was the first formal request for additional funding on this project. It was approved by the Vickers Board at their meeting on 25 November when:

> "Mr Plastow referred to the outstanding achievement in building the new Armstrong Works within the tight time-scale and to the very successful opening the previous day."[79]

Nevertheless the minutes note that a "formal letter of censure..." had been sent to the Chief Executive responsible for the Division. Willis recalled that at the time, both he and Blackmore felt that the Board would have approved the extra cost, and they therefore went ahead and sanctioned the additional expenditure themselves before approaching the Board for formal approval:

> "We had our knuckles rapped for this. We could have 'hidden' the extra, but we decided it was for the better and that the Board would have approved it anyway."[80]

Ewright prepared a formal and detailed report on the Dreadnought project, confirming the net overspend of £155,000 when account was taken of the lower than anticipated redundancy costs, the cash received from the sale of surplus assets and :

> "..the reasonable assumption that the Division's own direct labour and overhead absorbed on the project would have been incurred in any event."

Ewright's report does not criticise the Division's management for any failure of cost control:

> "I am satisfied that a very tight control was maintained throughout on the expenditure of the main contractor and that failure not to seek approval for excess expenditure in no way reflects on the way in which this part of the project was controlled."

The report concludes that the problem was not one of lack cost control:

> "...but first by failure to seek approval for additional costs and secondly failure to report the position to Group."[81]

The main recommendation was that a system of regular reporting between divisions and the Engineering Equipment Group should be instigated on all future major projects.

The scale and pace of the project appear to have placed a considerable strain on the cost reporting procedures to keep up to date. Further, the extent to which the budget was fixed very early in design development - when many of the building elements were covered by provisional sums in cost estimates and in tender documentation - means that the causes of the cost increases reported are difficult to identify.

However, of more interest is Ewright's recommendation following the financial review. This involved a small change in 'structural context', designed - it would appear - to limit some of the freedom which Blackmore in particular enjoyed on Dreadnought. And yet it was this freedom to be decisive and authoritative which appears to have been central to the VDS involvement - represented primarily by Blackmore - in the entire project and to the procurement of the new facility within such tight constraints of time and finance.

6.8 POSTSCRIPT

In 1986 the British Government, following lengthy negotiations, eventually sold its Royal Ordnance (RO) tank factory at Leeds to VDS. During these negotiations, Blackmore had been planning the construction of a new facility with Nicholson. The Leeds site contained a large number of old fabrication shops, stores and assembly buildings and, like Elswick, was incurring large running and maintenance costs (of some £400,000 per annum). The factory was in full production with the British army's Challenger I battle tank.

Nicholson recalled that Blackmore adopted a similar approach to the review (and, ultimately, reorganisation) of the RO business as at VDS and, before that, Fluid Power and Michell. The decision to invest in a new manufacturing facility (which is almost a replica of the Dreadnought building in Newcastle) appears to have been more a belief in the value of a new integrated facility in achieving the sort organisational and cultural change required than it was a direct result of the business review. However, no detailed material relating to the business background of the Leeds project was made available and access to conduct a similar case study to that on Dreadnought was not granted. It is interesting, however, to note the apparent similarities in approaches and between the procurement and project management arrangements adopted.

On Dreadnought 'II' Blackmore did not, eventually, have the same close, day-to-day involvement in design and construction as on Dreadnought 'I'. He instead appointed Jim Preston as project director once the building contract was signed. Wright Bates - now called the Wright Nicholson Partnership - were appointed project managers on a similar basis as before, with Alan Jones providing quantity surveying services. Although Waterloo Construction were invited to bid for the work and submitted a tender, they were unsuccessful, losing out to Shepherd Construction Ltd. Nicholson and Preston established identical cost control and management procedures based around the EI system, with thrice weekly project checks on site and more formal 3-weekly progress meetings. Once again major items, on the instruction of Blackmore, were purchased directly by VDS - ie cranes and cladding.

Preston recalled:

> "Blackmore said... 'you've got to get this thing done fast' because they had just received the last order for the Challenger 1s, and if this investment [Dreadnought 'II'] was going to pay dividends in the short term, we needed to build these tanks in the new factory where the overheads would be lower. So he said 'Right, we set ourselves a timescale of a year [in Newcastle], and that's what I'm setting you; that's what you've got to do.'"

Preston confirmed that similar budgetary and timescale constraints applied to the Leeds facility:

> "Cost was very important: if we got a problem then I had to find a way of reducing something else. We had a very disciplined procedure of going through all the EIs which the QS had costed in advance, and we would decide what we could afford. We'd have some things in the 'blue sky' category, things we'd like to do if the money was there, but most of these things got the chop."[82]

Construction at Dreadnought 'II' was completed and the factory was in production within 50 weeks of start on site.

6.9 FOOTNOTES

1 Vickers (1981), pp11-3.

2 Represented largely by Rolls-Royce Motors Ltd and associated companies, 90 per cent of which was acquired by Vickers from the British Government in 1980.

3 Vickers (1981), p13. By 1981, the Motor Car Group had become the most profitable.

4 Foss and McKenzie (1988) outline Vickers's role in the historical development of battle tanks.

5 By the late 1980s, for example, the VMBT (Vickers Main Battle Tank) Mark 5 consisted of a VDS turret fitted to a Krauss-Maffei hull (Krauss-Maffei manufacture the Leopard 2, a direct competitor to the Challenger tank built by VDS) and an optional weapons system.

6 In discussion with the author, 1992.

7 In discussion with the author, 1990.

8 During the 1970s Plastow initiated a modernisation programme at Rolls Royce which included major capital investment in new plant and equipment. Subsequently, annual output increased by 75 per cent.

9 In discussion with the author, 1990.

10 Goold and Campbell (1987), p101 and 106-7.

11 In discussion with the author, 1991.

12 In discussion with the author, 1990.

13 Goold and Campbell (1987), pp95-6.

14 In discussion with the author, 1990.

15 The Michell 'case study' is described in the Wright Nicholson Partnership's client guide "Thinking About Building".

16 Quotes in this section were in discussion with the author, 1993.

17 In discussion with the author, 1991.

18 In discussion with the author, 1990.

19 The Dreadnought CAR, 27 February 1981, unpublished.

20 In discussion with the author, 1993.

21 In discussion with the author, 1990.

22 In discussion with the author, 1993.

23 Quotes in this section from the Dreadnought CAR, 27 February 1981.

24 In discussion with the author, 1991.

25 In discussion with the author, 1991.

26 In discussion with the author, 1990.

27 In discussion with the author, 1991.

28 Details of the Chobham armour used on vehicles for the British army are classified.

29 In discussion with the author, 1991.

30 In discussion with the author, 1991.

31 In discussion with the author, 1993.

32 The Dreadnought was a revolutionary battleship built by Armstrongs in record time between 1905 and 1906.

33 In discussion with the author, 1992.

34 In discussion with the author, 1991.

35 Quotes from Willis in this section were in discussion with the author, 1990.

36 Quotes from Hammond in this section were in discussion with the author, 1991.

37 In discussion with the author, 1991.

38 The Dreadnought CAR, 27 February 1981. For the five options considered, recall that 'downside' represented closure and 'upside' represented continuation in business; the most attractive demand scenario considered for 'upside' was securing the Nigerian order which would provide a 'bridge' to the anticipated MCV-80 order for turrets by the mid 1980s - see section 6.4.3.

39 In discussion with the author, 1990.

40 In discussion with the author, 1991.

41 At that time, the Conservative Government of Margaret Thatcher had been in power for over a year and were beginning to initiate the large scale privatisation of state-owned enterprises which was to dominate much of the industrial and political scene throughout the 1980s - recall that Vickers had bought Rolls Royce Motors from the government only six months earlier.

42 In discussion with the author, 1990.

43 In discussion with the author, 1991.

44 In discussion with the author, 1990.

45 This approach has come to be called 'Selective Design Allocation' by the Wright Nicholson Partnership, and the practice has produced a booklet which outlines this approach, using Dreadnought as an example. Indeed, at the time of writing (early 1993), the practice was using this approach for the design and construction of a large manufacturing facility in Glasgow.

46 In discussion with the author, 1991.

47 The clear height from crane hook to floor level (8.25m) was determined by VDS, but the building height above the crane hook needed to accommodate the crane machinery was a specific manufacturer's requirement.

48 In discussion with the author, 1991.

49 In discussion with the author, 1993.

50 In discussion with the author, 1993.

51 Dreadnought Employer's Requirements, May 1981.

52 In discussion with the author, 1991.

53 All quotes from Vickers internal communication, 22 April 1981.

54 Vickers internal communication, 29 April 1981.

55 Wright Nicholson Partnership, undated.

56 Dreadnought Employer's Requirements, May 1981.

57 Recall that machine location was not precisely determined by VDS; the Employer's Requirements indicated that tenderers had some freedom to determine location to achieve a balance between VDS requirements and economy:

> "Drawing No. PD 1000 indicates the preferred positions of the machines. The Employer would entertain any alternative arrangement if this could be shown to reduce cost."

58 Minutes of the project meeting, 12 August 1981.

59 In discussion with the author, 1990.

60 In discussion with the author, 1991.

61 Minutes of the project meeting, 12 August 1981.

62 The system of cost control comprised the following:

1. Employer's Instruction (EI) which would communicate employer's requirements directly to Waterloo Construction and confirm whether additional cost implications were involved;

2. Request for Agreement of Proposed Employer's Instruction (RAPEI) which was intended to give notice of the intention to issue an instruction so that cost and programme implications could be examined prior to commitment; and
3. Comment on Drawings which would enable Wright Bates to comment on Waterloo Construction drawings and provide a preliminary assessment of cost and programming implications.

63 Minutes of the project meeting, 12 August 1981.

64 In discussion with the author, 1990.

65 Quotes in this section are from the minutes of progress meeting, 22 September 1981.

66 In discussion with the author, 1993.

67 Minutes of claims meeting, 18 November 1981.

68 In discussion with the author, 1993.

69 In discussion with the author, 1991.

70 In discussion with the author, 1993.

71 Minutes of progress meeting, 4 November 1981.

72 In discussion with the author, 1993.

73 Minutes of the project meeting, 6 January 1982.

74 In discussion with the author, 1991.

75 This is the date of the last report in the 'Financial Controls' file seen.

76 Letter from Blackmore to Deacon, 31 August 1992.

77 Vickers internal communication, 1 October 1982.

78 The overall increase - due to increases in construction cost, the manufacture of items by VDS and the increase in the project management fee - was, in fact, rather more than this. However, the 'incremental basis' takes account of the lower than expected redundancy costs, the enhanced revenue available from the sale of surplus equipment and stock from Elswick, and the assumption that VDS's own costs should not be charged directly to the project, all of which tend to offset the cost increase.

79 Minutes of Vickers Board meeting, 25 November 1982.

80 In discussion with the author, 1990.

81 All quotes in this section are from the Dreadnought financial review, February 1983.

82 In discussion with the author, 1992.

6.10 DREADNOUGHT: CHRONOLOGY OF KEY ACTIVITIES

1980

December	Blackmore appointed as chief executive of VDS Blackmore commenced review of VDS business Need for investment in new facility defined Scotswood Road site identified

1981

January	Architects involved in design development Alternatives to investment in new facility examined Work commenced on preparation of the CAR Hammond and Willis quantified operating costs of Elswick Outline factory scope and layout determined Quantity surveyor involved Project became known as Dreadnought Completion date and one year construction programme set
February	Work progressed on CAR Reorganisation of VDS clarified Blackmore consulted top management about CAR submission Project cash requirements clarified DTI assistance clarified CAR submitted Wright Bates appointed as project managers Soil investigation commenced
March	Formal project meetings commenced Procurement strategy outlined Change to lean-to offices incorporated in CAR cost plan CAR approved by Executive Committee, subject to DTI assistance Main Board approval for CAR Consideration of machine base design problems DTI assistance confirmed
April	Employer's Requirements clarify responsibility for machine base design Design development progressed
May	Overhead crane supplier appointed Cladding supplier appointed Tender documentation for main contract issued
June	Delay in finalising layout of heavy machinery
July	Main contract tenders returned Reductions negotiated and Waterloo Construction appointed as main contractor
August	Main contract works commenced on site Cost control procedures clarified Contractor's 'claims' correspondence commenced

1981 (cont'd)

September	Contractor's concern about workability of cost control
October	Finalisation of heavy machine layout VDS commenced manufacture of contract items
December	'Claims meeting' resolved contractor's potential claims Contract negotiated with Melec Ltd for machine move from Elswick

1982

January	Bad weather causes delay to main contractor's programme Bonus offered to regain programme in time for machine move
February	First formal notification that cost overrun likely
April	Overhead cranes installed to programme
May	Machine move form Elswick completed to programme
August	Certificate of practical completion issued
November	Final account agreed Factory opening ceremony Financial review indicates unauthorised cost overrun

6.11 KEY PERSONNEL FEATURED IN DREADNOUGHT CASE STUDY

Vickers personnel

Name		Affiliation/function
Best	T	Vickers Properties/Scotswood Road demolitions
Blackmore	G	Vickers Defences Systems (VDS)/chief executive
Carlton	P	VDS/production engineer
Davey	N	Engineering Equipment Group/chief executive
Dawes	B	VDS/works engineer
Ewright	R	Engineering Equipment Group/commercial director
Hammond	J	VDS/financial controller
Halroyd	H	VDS/managing director
Matthews	P	Vickers Plc/chairman of the board
Plastow	D	Vickers Plc/chief executive
Preston	J	VDS/deputy managing director (at Leeds works)
Willis	S	VDS/commercial director

Consultants, contractors and suppliers

Name/firm		Role
Alclad		Cladding
Keller		Steelwork
OTC Cranes		Cranes
Deacon	M	Waterloo Construction's contracts manager
Kier	A	Waterloo Construction's quantity surveyor/site agent
Jones	A	JNC Partnership/consultant quantity surveyor
Waterloo Construction		Main contracting
Nicholson	T	Wright Bates/project manager
Wright Bates		Architecture and project management
Melec Ltd		M&E installation and machine tool relocation

CHAPTER 7: THE PROPOSITIONS EXAMINED

7.1 INTRODUCTION AND OVERVIEW

Chapter 2 developed the argument that implementing a corporate capital investment decision is more a continuation of resource allocation than an end result of it. A conceptual scheme in the form of Bower's model of resource allocation was discussed in chapter 3. This scheme suggested propositions for study concerning management action as part of resource allocation during the decision and implementation stages of investment projects. Chapter 4 outlined a research strategy for the collection of data to enable the study propositions to be explored. The research data was presented in chapters 5 and 6 in the form of histories of aspects of the two investment projects studied, together with a preliminary analysis which related case material to the key processes in Bower's model.

This chapter turns more fully to consider the study propositions by comparing and contrasting the two case studies in terms of the key processes in Bower's model. The inter-case comparison is intended to highlight the extent to which the propositions offer useful explanations for management action as well as the phenomena which are difficult to explain in terms of the model. Although propositions are considered in turn, they are grouped together under headings as in chapter 3 (section 3.4). Conclusions are drawn under each of these headings and overall conclusions (section 7.7 below) are addressed at the problems raised in chapter 1 (section 1.1.2). The discussion ends with a brief assessment of Bower's model as providing a useful framework for the examination of management action during the decision and implementation stages of the corporate capital investment projects studied.

The cases were selected to provide a contrast in the extent to which major change occurred to facility definition during the decision and implementation stages (see section 4.3.2 above). There were other differences between the cases, however and one in particular provides an important background to the following discussion of project definition. It is that whereas K2A involved the development and manufacture of a new pharmaceutical product around which there were high levels of uncertainty in terms both of the production processes and the anticipated market demand, Dreadnought involved the transfer of production operations with known technology for the manufacture of products to order. The propositions concerning the process of definition will now be addressed.

7.2 THE PROCESS OF DEFINITION

This part of the analysis addresses propositions A and B and is concerned with the process of facility definition prior to the submission of a funding application to top management. The focus is therefore on the origins of the investment projects, the involvement of the construction industry in the definition processes and the role of those managers with responsibility as construction client.

7.2.1 Proposition A

Proposition A states that:

> In the large diversified firm the process of definition occurs across many levels of the management hierarchy and involves input from construction firms outwith the corporate structure.

This proposition would appear to be supported by the data presented in respect of both projects. In both firms the projects of interest arose from the divisions; although definition involved input from personnel at several levels in the organisations other than from where the projects originated, the extent of this varied between the cases. The construction industry was also involved in this process and it is notable for the purposes of the present study that Bower's model makes no allowance for this. More detailed consideration of the elements of the definition process reveals further similarities and differences between the cases.

The origin of projects: the source of the discrepancy

In Bower's model, the process of capital investment is triggered by a discrepancy which is identified by 'facility-oriented' managers in response to information concerning either production costs, quality or capacity. Such discrepancies are identified at the lower levels of the corporate hierarchy, ie at the level of 'product group' or 'area general management'[1]; in Glaxo's terms this would equate to the Glaxo Group Research/Pharmaceuticals general management level and, in Vickers's terms, to the Defence Systems division general management level. However, the precise source of these discrepancies may be expected to vary between firms and, indeed, between different divisions or groups in the same firm.

Although the initial identification of the discrepancy is rather lower down the hierarchy in the case of K2A than implied by Bower - Underwood had managerial responsibility for technology transfer within TDD, a department in Glaxo Pharmaceuticals - the location of the source of the discrepancy on Dreadnought is of more interest. In that project the discrepancy appears to have originated from a higher hierarchical level than indicated by the model - that of chief executive of the Defence Systems division. Although this manager's job may include responsibility for facilities, it can hardly be described as 'facility-oriented' in the sense implied by Bower (see footnote 2 to chapter 3). The role of top management in the process of definition on both projects is considered under propositions E and F below.

The nature of the discrepancy

In the case of K2A the discrepancy was defined between the production capacity available and that likely to be required. Forecasts of market demand for CAOS were extremely uncertain and fluctuated considerably over the period examined. While Underwood's initial facility definition may be seen in terms of a 'bid' to locate production in the UK, the discrepancy prompting definition once the question of location had been resolved remained one of capacity.

On Dreadnought the discrepancy was defined by Blackmore in terms of costs - the operating costs of the existing facility were too high. However, this only partly explains the nature of the problem and its resolution.

In particular, a key component of the discrepancy was the belief that a new facility could help achieve the re-organisation of the VDS business which Blackmore desired. In these terms the discrepancy was between the reality of existing operations - with all their apparent inefficiencies - and a vision of efficient manufacturing modernity. And while this discrepancy was identified by Blackmore prior to his appointment to VDS - note Nicholson's recollection that Blackmore had considered the problem of refurbishing Elswick while still at Michell - his was not an entirely new and original contribution: "Everybody knew there was a potential crisis..." according to Willis. Furthermore, there is a sense in which this discrepancy is one of capacity - in that a new facility would provide opportunities to respond to potential order situations which the existing facility would allegedly deny - which is articulated in terms of cost.

However, the emphasis on cost may be examined further. Arguably the costs of a transaction are more easily measured than the benefits; indeed, the sophistication of Blackmore's definition may have been beyond the capacity of the available accounting systems to measure and evaluate. Although a case is argued in the CAR for new facilities, there is little attempt to quantify the benefits of these. Instead, the focus is on the high operating costs in the existing premises. And the case made in these terms appears to have been sufficiently convincing to persuade top management that investment was needed. The point here, however, is that the emphasis on a discrepancy in <u>cost</u> - whilst neatly accommodated within Bower's model and capable of being articulated to top management in terms on which a decision could be made - does not fully explain the motivation behind corporate capital investment in this instance[2].

Defining the scope of the facility required: the initiating phase of definition

While the discrepancies leading to facility definition were essentially different between the two cases, these led quickly to a consideration of the same question: "What size of facility do we need?" One would expect that where the discrepancy was one of capacity, this question would be more easily resolved than where it was one of cost - or quality. In these cases however, the reverse applied: the capacity discrepancy of K2A was followed by a more protracted and problematic definition process than the cost discrepancy on Dreadnought. This may appear somewhat counter-intuitive - and indeed, is contrary to the findings reported by Bower, where capacity discrepancies led to speedier definition than where the discrepancy was in cost or quality[3]. More detailed comparison of case material is needed to explore this question.

On K2A there were considerable uncertainties about the location of production, the production process, the product launch dates and demand volumes throughout the definition process. These uncertainties were not present to the same extent - if at all - during the Dreadnought definition.

In the initial stages, however, it was uncertainty over the location of production which slowed the facility definition process on K2A. Hatfield, as a facility-oriented manager at the UK production site, whilst capable of pressing his superiors (Murray and Chandler) for decisions on process and market forecasts, was less involved in the decisions as to the location of production which were taken at the more senior GTC. Indeed, these latter decisions involved a number of Glaxo companies (Glaxo Inc and Glaxo Italy) as well as different levels of the organisation (both the GTC and the ad-hoc Project Team concerned with the location of secondary production). By contrast, on Dreadnought there was little uncertainty about where production was to be located. Blackmore had contemplated (and rejected) the option of refurbishing the Elswick works prior to his appointment to VDS. There was apparently little doubt or query about his favoured site of Scotswood Road.

Further, the (cost) discrepancy giving rise to the Dreadnought definition did not vary to the same extent as the (capacity) discrepancy on K2A. Problems with registration and consequent revisions to CAOS launch dates in particular delayed the definition process on K2A. And uncertainties in the production technology were at the heart of the problem of facility definition. On Dreadnought, production technology was known and although decisions as to the precise layout of machinery extended well into the construction process, by then the scope of the building had been determined. By contrast on K2A, doubts about the process technology led to major changes in facility definition following submission of the CAR.

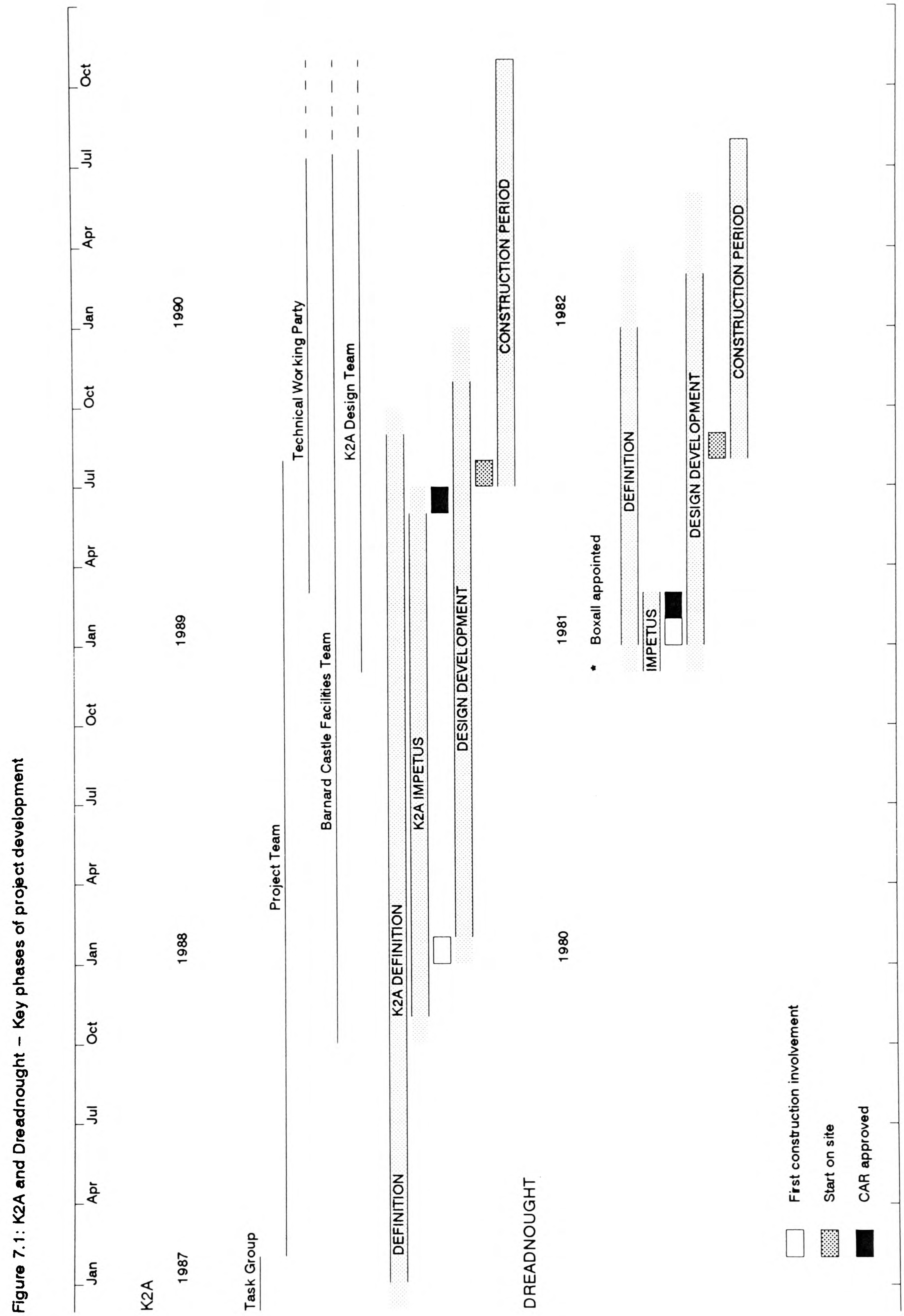
In summary, the K2A definition process took place over a long period of time and across many levels and locations of the firm. (Figure 7.1 below plots the key processes of Bower's model against the key phases of project development on K2A and Dreadnought.) Recall how Underwood's definition changed over time, the extent to which market forecasts varied and the intervention of Chandler (and Clarke from the GTC) at critical junctures in facility definition. This is in stark contrast to that on Dreadnought, where the process was speedier and did not spread so extensively across the firm - more senior management were kept informed of Blackmore's definition but did not participate directly in it. Although some of these differences may be explained by differences in product/markets between the firms examined, and by the source and nature of the discrepancies giving rise to facility definition, it is also important to consider the individuals and groups involved and the management of the facility definition process. Before turning to this, however, it is appropriate to consider the involvement of the construction industry in the definition process which is also the subject of proposition A.

The involvement of construction in the definition process

The second part of proposition A suggests that construction firms outwith the corporate structure will also be involved in the definition process and on both projects informants generally felt that the construction consultants were involved relatively early. On K2A, Reid of Dewhursts had been providing ad-hoc advice since at least January 1988, assisted by Hamburg & Co., although the first formal design team meeting was not held until November 1988. On Dreadnought Nicholson recalled discussing the accommodation needs of VDS with Blackmore prior to Blackmore's appointment as chief executive in December 1980 (Nicholson began work on Dreadnought more formally in January 1981).

On each project the CAR submitted contained a quantity surveyor's cost plan based on an architect's outline or scheme design[4]. This played

Figure 7.1 K2A and Dreadnought - Key phases of project development



an important role in the identification of the amount of funding available and the subsequent financial limit within which funding relating to the building project was allocated. It is important to note here, however, that the involvement of the construction industry in facility definition - though hardly surprising - is not considered in Bower's model nor in other theoretical and empirical treatments of corporate capital investment reviewed in chapter 2. The implication is that such involvement is associated with implementation and, as noted above (section 2.3.6) implementation is a largely ignored separate process occurring following top management approval of an investment proposal. In these terms, there is a sense in which implementation has begun prior to formal top management approval - at the very least resources are being allocated for the construction expertise necessary to help define the new facility. The point is returned to below in the examination of the role of construction in providing impetus to help move projects towards funding.

Of more significance to the present study however, is that the involvement of construction in the definition process introduces additional participants and information to the definition process which must be managed. This is the subject of proposition B.

7.2.2 Proposition B

Proposition B states that:

> The process of definition will be managed as an 'integrating-phase' activity by managers to whom the firm will delegate its responsibility as construction client.

This proposition would appear to be supported by the data presented in respect of both projects. Those managers who identified the discrepancy leading to facility definition - Hatfield and Blackmore on K2A and Dreadnought respectively - not only carried out the integrating phase of the definition process, both in technical and financial terms, but were also responsible for the management of the construction contribution to facility definition. Detailed analysis allows key differences between the cases to be explored more fully.

Structures for the management of definition

Glaxo have developed a specific form of project organisation for the management of new product development. This recognises that there is a difference between aspects of definition concerning the overall project and individual production facilities. While the strategic planning unit (SPU) was responsible for capacity planning for Group needs worldwide, individual production site project teams were responsible for facility acquisition. Both of these reported to the more senior Project Team which oversaw all aspects of product development. In the early stages of product development the likely production site was involved - Underwood of TDD in the case of K2A - to 'trigger' facility definition if needed.

By contrast, VDS did not have the same recurring need for facilities - they had, after all, occupied the same works in Elswick for over 70 years prior to Dreadnought - and consequently had not the same developed and structured approach to the procurement of facilities as Glaxo. Although the management of facility definition on Dreadnought was dominated by Blackmore, it was possible for him to do this partly because of the lack of a formal and pre-determined project structure.

The integrating phase of definition

A key distinction between the projects is the extent to which the sources of information needed to progress facility definition were spread widely across the organisation in Glaxo and contained in a relatively close knit group in VDS. Further, with K2A some of these sources were widely dispersed in time; information on the related questions of launch dates, market volumes and pack types became available at different times in the process of definition, for example. Clearly there was a need to integrate these data into the process of facility definition and construction. Indeed, this is why Glaxo had identified the need for in-house project management (Hatfield).

Hatfield's problem was to define a facility to accommodate a largely unknown process producing an uncertain quantity of product to an uncertain timescale! Because of the requirements of his job, and because the likely launch dates in major markets implied rapid design and construction, Hatfield's concern was primarily with the technical aspects of facility definition. But his concern was also with 'integrating' the need for facilities with the need for corporate earnings in the sense in which Bower defines the integrating phase of definition[5]. Once it was likely that Barnard Castle was to be one of the production sites and the need for K2A was defined, Hatfield pressed upon both Murray and Chandler the need for substantial investment and enquired of them the kind of funding which was likely to be available - and in the process gained their support (see below under 'impetus').

Therefore, while one role of the integrating phase of definition may be said to be concerned with financial matters - and on K2A such integration was largely between different hierarchical levels - there was another, separate role concerned more with technical definition which in this case involved the integration of different sources of information in a rather more horizontal than vertical manner across the firm.

Both of these processes are also discernible with Dreadnought. First, however, the process of technical definition was managed in a different manner than on K2A. On Dreadnought, Blackmore assembled a small team initially comprising Hammond and Willis and, later, Carlton and Dawes on production/engineering matters. In some respects this is comparable to the CAOS project team, in that it was primarily concerned with the overall project rather than the specifics of the facility. However, it was far less formal - there was no documented record or minutes of meetings, for example, and, although meetings were held regularly, these were on more of an ad-hoc basis than with CAOS. This team was also considerably smaller and more focused on Blackmore's perception of what constituted the 'discrepancy' defining the need for capital investment. It progressed matters quickly "before he [Blackmore] got too close to" the VDS business. In contrast to K2A - where Parker, who led the CAOS project team, rarely became involved in facility definition or acquisition - Blackmore also led the process of facility definition and acquisition.

Fundamentally, however, the central role of the new facility in helping to achieve the radical change which Blackmore perceived was necessary at VDS meant that facility definition comprised his largely personal view of what was required. Decisions on the extent of the workforce to be retained, for example - which were taken by Blackmore - had a direct impact on the size of the facility required to accommodate it. Although the need for integration in the technical process of facility definition would appear far less on Dreadnought because information and people were less widely dispersed than for K2A, the key difference is that on Dreadnought much of this information came from the individual carrying out the integrating-phase task. By contrast, not only were the sources of information more widely dispersed on K2A, the kind of information available was frequently not directly relevant to a consideration of facility definition. In particular, information from the discussions of the CAOS Project Team about such technical matters as process development and pack types and sizes, for example, needed to be 'translated' by someone like Hatfield into measures of facility size and cost. (The discussion of the addition of SLS to the CAOS formulation which - inadvertently - made the sachet presentation feasible and required additional filling capacity is illustrative of the problems that had to be overcome.)

On Dreadnought, Blackmore was also concerned with integrating the need for the new facility with the need for corporate earnings, as is reflected by his close contact with Plastow and Davey (chief executive of the Engineering Equipment Group) during the definition process (see below under 'impetus'). In a sense, the same kinds of integration in the definition process are evident here as on K2A: financial, which would appear to occur vertically across the hierarchy, and technical, which would appear to occur more horizontally. However, Blackmore's position as chief executive of VDS meant that the needs of the "sub-unit parts and the corporate whole"[6] were not as widely differentiated as on K2A (nor, for that matter, in Bower's 'National Products'). Furthermore, his position as project initiator and joint leader of project and facility 'teams' implies also that the need for integration on technical matters was not so great.

7.2.3 Discussion

Consideration of propositions A and B has provided useful insights into the case material and has helped explain management action during facility definition. The concept of a discrepancy in either capacity, cost or quality leading to facility definition tends to conceal the rather more sophisticated nature of the discrepancy perceived by Blackmore on Dreadnought. Indeed, this raises the broader question of whether discrepancies leading to the definition of an investment project are self-evident, or rather more perceived when they might usefully provide a focus and opportunity for particular interests. The definition process on K2A too may be viewed in these terms, at least prior to the finalisation of the location of production when Glaxo Pharmaceuticals and Glaxo Inc both appeared to be 'bidding' for production capacity. Mintzberg *et al* (1976) consider that when problems are matched with opportunities, managers are more likely to initiate decision making action.

The extent to which the definition process was spread across the hierarchy differed between the cases, and this was seen to be partly related to the seniority of the original definer and partly related to the nature of the respective product/markets rather than to the nature of the discrepancy *per se*. In line with empirical studies of capital investment reviewed in chapter 2 - most notably Carter (1971), King (1975), Bromiley (1986), Marsh *et al* (1988) - definition was a 'bottom-up' process. The extent of top management involvement is examined more fully below.

An examination of the involvement of construction in definition raised an important question concerning the extent to which implementation - as characterised within much of the investment literature - is the result of an investment decision or more a part of it. Because the integrators of facility definition on both projects were also those who initiated them, there was a direct role for definers in representing their firms as construction client.

Proposition B has proved to be particularly helpful in clarifying the role of the integrating-phase activity in the management of the definition process. Although the need for integration relating to the technical content of facility definition was seen to vary between the cases, the inter-case comparison has identified key aspects of the process requiring integration. In contrast to Dreadnought, a greater level of integration was required for facility definition on K2A. First, the sources of information - primarily people - necessary for facility definition were more widely dispersed throughout Glaxo. Secondly, the kind of information - the terms in which that information is normally expressed - was varied and needed to be integrated into the facility definition process (recall that on K2A, early market forecasts were provided in terms of tonnes of primary product, which were converted into tonnes of secondary product and numbers of packs by Hatfield). And thirdly, the different points in time during which these people and information came together were also widely dispersed on K2A. In this latter case the difference between the projects was most extreme: whereas on K2A the time between project initiation and submission of the CAR was more than 2 years, on Dreadnought it was slightly less than 3 months.

The process of definition is considered by Bower (1970), King (1975) and Burgelman (1983) as a largely technical and economic process. However, proposition B allowed the integrating-phase activity to be considered in terms of a largely horizontal process concerning technical definition and a more vertical process involving the reconciliation of the business need for investment with the corporate need for earnings. It may be noted that in respect of this latter process, there was little attempt made by the integrators on both projects to express the financial case in terms of return on investment. This point is returned to below under 'The role of top management', section 7.5.

7.3 THE GENERATION OF IMPETUS

This part of the analysis addresses proposition C and is concerned with how the investment projects moved through their respective organisations towards final authorisation which Bower argued depends on 'impetus'. While this is a largely political process, the focus here is on the sponsorship of proposals for funding by managers at successively higher levels in the hierarchy[7] and on construction's involvement, rather than on the interpersonal behaviour of individual actors *per se*.

7.3.1 Proposition C

Proposition C states that:

> Those managers with responsibility as construction client can use the involvement of construction to help generate impetus, in particular, by:
>
> i) requiring expenditure on the project prior to final authorisation by top management;
>
> ii) making the achievement of project objectives - for example as to cost or timing - contingent on an early approval of the proposal.

The commitment of funds prior to top management approval of the investment proposal was a clear element in the procurement strategy on K2A, and would appear to have contributed to impetus, although other factors also made their contribution. Proposition C (i) would appear to be supported by the K2A case material presented. However, on Dreadnought the commitment of funds was not as great nor as systematic as on K2A, and the proposition is not supported to the same extent. There is little support for proposition C (ii) in the case material presented in respect of either project. More detailed analysis of the process of impetus allows important similarities and differences between the cases to be explored.

Recall that, as with the process of definition, there are three distinct phases of impetus in Bower's model: initiating, integrating and corporate. The integrating phase is expected to be the primary determinant of impetus.

The initiation of impetus

The impetus of interest here relates to proposals for funding as they move toward authorisation. Although Parker, for example, as chairman of the CAOS project team helped progress the overall project concerned with bringing the product to the market, his contribution to impetus for the K2A investment proposal was less direct. While he helped ensure that production would take place in the UK by having Glaxo Pharmaceuticals represented on the task group and Project Team early in the definition process, his interest was primarily in the development and launch of the product; the question of where it was to be produced was a somewhat secondary consideration.

Almost as soon as the discrepancy was identified in respect of UK capacity, Hatfield initiated the impetus process by involving Chandler and Murray, both senior managers at the UK production site who would have to support the proposal as it progressed along the formal 'authorisation chain'. Indeed, Chandler (a director of Glaxo pharmaceuticals) was to become one of the main project sponsors as it progressed toward final authorisation by the Main Board. Initially, he contributed impetus by confirming to Hatfield that a proposal in respect of new facilities would be submitted. Hatfield kept Murray informed of key developments relating to facility definition to the extent that, when the need for the K2A facility was clarified early in 1988, Murray endorsed Hatfield's definition to Chandler.

On Dreadnought there is a sense in which Blackmore - given his authority and the purpose for which he was appointed to VDS - was able to provide impetus for the project which he initiated. The time available for impetus was short; indeed, the seniority of Blackmore's position meant that the proposal for funding did not have a lengthy journey up the management hierarchy.

The integrating phase of impetus

The nature of impetus is that it is progressive and cumulative. As the K2A investment proposal progressed up the hierarchy it gathered more support. Agreement at project team meetings that considerable investment would be needed to support product launch may be viewed as a form of impetus. Furthermore, the inclusion of K2A in Glaxo Pharmaceuticals' capital projects list and Cargill's intention to use "Shield's comments to good effect" regarding the problem of underfunding all reinforce the expectation that an investment proposal was forthcoming and would be approved.

All of the key managers whose support was required on K2A to progress the proposal to the Glaxo Pharmaceuticals Board level - Cargill, Murray and Chandler - had already been involved in definition by the time the CAR was submitted. Additionally, Nathan - who provided the important strategic planning support - was also involved in estimating capacity requirements.

On Dreadnought, top management appears to have been the only significant source of impetus other than Blackmore. Their more direct role in the provision of impetus is discussed below. Blackmore's efforts in keeping Davey - the Engineering Equipment Group chief executive - and, in particular Plastow, informed about the development of project definition were clearly influential in the rapid progress of the project to final authorisation. With this support, Hammond recalled, the proposal effectively bypassed the Business Appraisal Department.

The contribution of construction to impetus

On both projects, the initiators of facility definition perceived the need for the new facility to be provided quickly. Rapid design and construction creates its own particular requirements[8] which were used to help generate impetus for the approval of proposals, but in different ways on each project. Glaxo's frequent need for 'fast track' facility acquisition meant that there was an established procedure for approving expenditure for early elements of work prior to funding approval for the entire project. Where the amount of these 'pre-spends' is large relative to the work remaining, a substantial proportion of project funding may have already been committed prior to top management review of a funding proposal.

Hatfield's plan of February 1989 for the authorisation of pre-spends envisaged the expenditure of some £1.7m (22 per cent of the total eventually requested from the Board) prior to top management approval. In the event, not all of this was required as approval of the main CAR was granted in June 1989. Nevertheless, managers in the authorisation chain had approved some £0.6m of pre-spend by the end of April, providing tangible evidence of their commitment to the K2A proposal. The expenditure of funds available to a manager is a clear signal that that manager supports the proposal for investment. It has already been noted that the risk of writing off pre-spends in the event that top management do not approve the main proposal effectively passes to them (see commentary on section 5.6.8 above). By the time the proposal is reviewed, so much time and money has already been invested that it is difficult to reject it (Aharoni, 1966).

There was no such procedure in Vickers. However, by setting a tight timetable for the completion of the facility - within 18 months of submitting the CAR - Blackmore ensured that work on facility planning and design would have to continue throughout the period of preparation and approval of the CAR. Recall that Wright Bates were appointed as project managers shortly before Blackmore submitted the CAR and that design development and preparations for construction progressed prior to funding approval by the Executive Committee.

There were no indications in the arguments submitted to top management in support of either proposal that facility cost or time of availability was contingent upon early approval (proposition C (ii)). Although top management were aware of the importance of timing to both projects, the need for early approval was not made explicit in either proposal submitted. While the essential argument in the K2A CAR was that the facility was required to meet CAOS demand from 1991, the pre-spends ensured that it was more the act of approval rather than its timing which was important. Blackmore's confidence in the success of the Dreadnought proposal has already been noted, and there was no suggestion in the CAR that failure to approve the proposal by a given date would jeopardise the time of availability of the facility.

Because of the more substantial and systematic expenditure on K2A prior to top management approval, the contribution of construction to impetus is rather greater than on Dreadnought. This kind of impetus was not considered on the four investment projects examined by Bower nor in other empirical studies of the capital investment process reviewed in chapters 2 and 3. Clearly, managers must be confident that the investment proposal will be approved before they themselves will allocate resources which may have to be written off if the proposal is rejected. Indeed, this confidence may be improved if top management indicates that the proposal is likely to be approved or if top management are involved more directly in either definition or impetus. The role of top management - ie the corporate-phase - in impetus can now be considered.

The corporate phase of impetus

The investment proposals in respect of both projects were approved without being referred for further study (Bower, 1970; King, 1975; Marsh *et al*, 1988). This was helped by the impetus each had attracted by the time they were reviewed by top management. Top management's role in definition and in the determination of structural context is considered in section 7.5 below.

Although access was not granted to the top management level in either case, there are indications from both that top management expected to receive an investment proposal in both cases. Impetus also involves a process of communication or 'transmission' (King, 1975) which may help set criteria and assumptions for definition. On the CAOS project top management had been supportive of earlier investment for a different form of the same product. Once the K2A facility began to be defined, they had been kept informed by Hatfield and his superiors of the likely level of funding which would be required. Indeed, they appear to have confirmed to those involved more directly in facility definition that the funding limit proposed was acceptable. Although this helped clarify facility definition, it was more their expectation that a proposal would be submitted - and the support thus implied - which contributed impetus.

The close relationship between Blackmore and Plastow on Dreadnought has been noted, and it is clear that top management expected to receive an investment proposal from Blackmore shortly following his appointment to VDS. Indeed, Plastow and Davey appear to have provided considerable support which effectively guaranteed the approval of Blackmore's proposal when the Board met to review it.

7.3.2 Discussion

The concept of impetus has helped explain how both projects studied were moved towards funding whereby managers at higher hierarchical levels than from where the proposals originated lent their support (see, for example, Aharoni, 1966; King, 1975; Quinn, 1980; Burgelman, 1983; Marsh *et al*, 1988; Schilit, 1990). Proposition C (i) has proved particularly helpful in directing attention at the role of construction in this part of the investment process. However, unlike facility definition, where construction industry involvement was direct and explicit, with impetus it was more the requirements of rapid construction which helped contribute financial commitment in particular. While construction's contribution to impetus was thus not explicit, those managers initiating impetus were able to use this to help progress their proposals towards funding.

The point has been argued above that the involvement of construction in the definition process is an indication of the extent to which the decision and implementation stages are not as easily separated as implied in the literature on capital investment decision making. Indeed, the commitment of substantial financial resources in advance of formal authorisation of the investment proposal poses a direct challenge to those who view the corporate investment decision as a "single act of top management deliberation". Implementation may have already begun before the decision has been taken.

On both projects, those responsible for project definition also initiated the impetus process. They both appear to have used information as a key tool in helping secure more senior managerial commitment (King, 1975; Schilit, 1990). On the early stages of K2A, Hatfield kept Murray informed of how facility definition was progressing and in the process, appears to have won his support. On Dreadnought, Blackmore used information on the development of definition to provide the <u>opportunity</u> for top management to suggest and make amendments to the proposal before it was finally presented for approval. This opportunity was not used materially to affect the definition process - neither did Murray or Chandler alter Hatfield's K2A definition, at least in the early stages. However, impetus appears to have been reinforced in both cases by providing information to senior management on the development of definition <u>and</u> by providing access to the process.

Both Blackmore's involvement in providing impetus for his own proposal, and Plastow's involvement in providing impetus for a proposal he would have to evaluate raises questions about how individuals adopt dual roles of project initiation and sponsorship (Blackmore) or of sponsorship and adjudication (Plastow). Such questions are beyond the scope of this thesis but raise issues for further investigation which are returned to briefly in chapter 8.

As with the definition process (see above), Bower found that three out of the four projects he examined:

> "derived their impetus from division management's concern for lack of capacity. ...where this concern was absent... the project never achieved the impetus required to move to CAR approval"[9].

Despite the capacity concern on K2A, impetus at an early stage was not sufficient to overcome the considerable uncertainties about process development and market forecasts which slowed the facility definition process. Conversely on Dreadnought, the absence of a concern about capacity did not hinder the provision of impetus and the speedy authorisation of the CAR. For K2A, the level of uncertainty in Glaxo's product/market environment is particularly important, and this is discussed below. On Dreadnought, the background to Blackmore's appointment, his relationship with top management and his direct role in project definition and impetus all appear more important to impetus than the nature of the discrepancy.

A delay between submission and approval of a CAR is likely on most major corporate investment projects. On K2A it was some 3 months and partly the reason why pre-spends were required. However, the literature on capital investment is largely silent about what happens during this period; presumably, those involved in the project must await the outcome of top management review of the proposal before progressing further. On both projects studied there was considerable activity during this period in progressing facility definition and in preparing for construction. Clearly both project sponsors were confident that approval would be forthcoming and this is a further measure of the impetus generated. However, both facilities were to be constructed quickly and it would be interesting to examine management activity during this period on projects where the time constraint was not so great.

7.4 CHANGING PROJECT DEFINITION PRIOR TO FUNDING APPROVAL

The progressive and cumulative nature of impetus implies that as an investment proposal moves towards funding, the less likely it is that the facility definition embodied within it will be changed. This part of the analysis addresses proposition D and is concerned with how impetus is overcome - and new impetus added - to get facility definition changed.

7.4.1 Proposition D

Proposition D states that:

> The original perception of a discrepancy identified by facility oriented managers will constitute the sole source of facility definition unless explicit steps are taken higher up the management hierarchy to introduce other issues.

The incorporation of changes to facility definition involving the 'batch plant' on K2A and the 'lean-to' offices on Dreadnought would appear to lend support to this proposition, though this latter change originated from outwith the corporate structure. A more detailed comparison of both cases indicates the extent of impetus required to change facility definition.

The origin of change: the source of the discrepancy

The change in granulation plant from the 1000kg machine to two 500kg machines on K2A originated with Chandler, a senior manager comprising the final formal layer of approval before the proposal was passed to the GTC en route to the Main Board. Chandler also had responsibility for meeting "the needs of the market" with CAOS. This dual responsibility - for endorsing the proposal as it passed to his superiors and for implementing the production plan contained within it - meant that he was in a position to act on his 'insecurity' over the single tower to change definition at a late stage. Although he had been kept informed of progress with project definition and had opportunities to suggest changes early in the process, he clearly had a change of mind when he came formally to endorse the proposal. The 'discrepancy' which led him to revise the technical content of definition can be seen as between what his position required of him ("what the corporation wants of me"[10]) and the needs of the Glaxo Pharmaceuticals business.

On Dreadnought, the detail of the facility definition was also changed following submission of the CAR and before its review and approval by the Executive Committee. Here a discrepancy was identified by Nicholson in the quality of the office accommodation to be provided.

Impetus

Both changes occurred after the proposals had been formally submitted - ie when the model implies that definition is substantially or wholly complete - and therefore required considerable impetus to overcome that already provided and to "push ... change through"[11]. On K2A Chandler - like Blackmore on Dreadnought - was able to provide impetus for his own proposal. Indeed, his seniority and authority allowed him to insist initially that the change be incorporated without revisions to the budget although the budget was - with Chandler's support - subsequently revised. Further impetus was available from Parker who - as GGR's director and chairman of the CAOS Project Team - was a formidable ally in helping ensure that the change would be incorporated.

Blackmore provided the impetus needed to incorporate the 'lean-to' change into the investment proposal. Nicholson's close relationship with

Blackmore - described by Nicholson as "an equal partnership" - meant that although this change arose from outwith the corporate structure, the source was equivalent to senior management level.

7.4.2 Discussion

Both changes discussed were different in origin and nature, and both were incorporated quickly, primarily because of the impetus provided. This came from a higher hierarchical level than that where the proposal originated in the case of K2A, and from the main source of impetus in the case of Dreadnought. Chandler's change to the K2A definition is particularly interesting in that the same information was available to him as to those facility-oriented managers who had defined the facility up to that point. However, the discrepancy in capacity was perceived in a rather different manner by Chandler. In particular, his perception of the risk associated with the single tower plant configuration was different to Hatfield's because of his (Chandler's) direct and ongoing responsibility for meeting market need.

Although senior management were prepared to change the technical content of facility definition in both cases prior to top management review and approval, there was apparently more reluctance to change the financial content (recall Chandler's insistence that the two towers be provided without exceeding the budget, and Blackmore's insistence that the lean-to offices be provided within the budget for Portakabins). One possible explanation is that cost increases may have reflected poorly on managerial judgement and competence. The integrating phase of definition - whereby the need for corporate earnings is reconciled with the investment needs of the business - is likely to have revealed to top management the extent of the investment funds to be requested. There is a sense that the financial limit may have already been set prior to the formal submission of the CAR for approval. The point is returned in section 7.6 below.

7.5 THE ROLE OF TOP MANAGEMENT

This part of the analysis concentrates on the role of top management in facility definition which is the subject of propositions E and F.

7.5.1 Proposition E

Proposition E states that:

> Top management's direct role in the definition of facilities is restricted to a budgetary/financial sanction.

The direct involvement of top management in each case in the facility definition process would appear to be restricted to the imposition of a financial limit on expenditure by the approval of the investment proposal. Although this provides support for proposition F, concentration on direct involvement misses important aspects of the contribution top management made to facility definition on both projects.

The corporate phase of definition

Glaxo, under Girolami, had been divesting itself of a number of subsidiaries to concentrate on the development of prescription medicines in a small number of therapeutic areas. This determined the choice of markets and the products to be sold in them. In Glaxo, these choices were not decentralised to the same extent as in Bower's 'National Products'; the Development Policy Committee determined which products were identified for research, targeted for development, funded and eventually brought to market. Although the precise origins of the product 'idea' were unclear (Cannon, for example, wondered whether the idea of an oral suspension had originated in the research laboratory or in the form of a request from senior management), it is apparent that the K2A investment proposal was developed within a wider business planning process which was concerned with markets and products rather than specific investment proposals[12].

Furthermore, although top management did not participate directly in the K2A definition process, it was possible for managers above the level at which the facility was being defined to intervene. Recall the intervention of Clarke - a senior manager in Glaxo Holdings - to query whether the facilities proposed in Italy and the UK "make the most sense locally". Marsh *et al* (1988) categorise this kind of senior management involvement in definition as "questioning assumptions"[13].

On Dreadnought, the role of top management is more discernible, though their involvement here would appear to be less direct than in the case of K2A. The role of Plastow as chairman of Vickers in appointing Blackmore "to do something" with VDS is particularly important given Blackmore's history of re-organisation around new facility investment at both Michell Bearings and Fluid Power. Although this was the first crucial step in the definition process, top management did not participate directly in facility definition after this.

7.5.2 Proposition F

Proposition F states that:

> Top management can influence facility definition indirectly by manipulating the structural context within which lower level managers operate.

In Bower's analysis, structural context includes the organisational and administrative elements which influence the perceptions and actions of those managers more directly involved in definition and in the provision of impetus[14]. Bower argued that top management - who do not participate directly in either definition or impetus - can nevertheless influence these processes by manipulating structural context.

Although the project organisational structure for CAOS/K2A was changed, most notably by the formation of the Technical Working Party (TWP) to help with project planning and co-ordination, this was neither initiated nor implemented by top management. Furthermore, it had little immediate effect in resolving the problems of the co-ordination of process development and market forecasting in particular. There was no discernible change to structural context by top management specifically to enable or influence the Dreadnought facility definition. Although proposition F would appear not to be supported in either case, organisational changes in Vickers prior to the appointment of Blackmore may be said to have had an influence on the Dreadnought definition process. These will now be examined, followed by the more detailed changes to project organisation on K2A.

The corporate phase of determination of context

Recall that informants spoke of changes at Vickers under Matthews and Plastow whereby responsibility for strategy development was devolved to divisional management. This included the responsibility to initiate and progress capital investment decisions. While these changes were initiated prior to Blackmore's appointment and were not intended specifically for the Dreadnought project, they helped give him the freedom and authority which were fundamental to his dominance of the decision and implementation stages of the project. Such was the freedom Blackmore enjoyed that a subsequent and more specific change to structural context - involving a change in reporting procedures as a result of Ewright's financial review - attempted to limit this freedom on future projects. However, this revision to structural context did not involve any changes to the organisation structure per se and seemed intended to re-affirm top management's responsibility for the authorisation of capital expenditure.

Blackmore's appointment to VDS has already been noted as involving top management in the initiation of the definition process. However, the concept of determination of context would appear to offer an inadequate explanation for this kind of top management involvement. It is more likely that Blackmore was appointed for his personal qualities, though it may be noted that the Dreadnought project he initiated was a central element in the substantial changes to structural context he initiated at VDS.

Detailed changes to project organisation

Glaxo's specific form of project organisation for new product development and production has already been noted (section 7.2.2 above). The formation of the Technical Working Party (TWP) represents a change to this aspect of structural context. Recall that Hatfield located the origin of this change within TDD; recall also that the "functions, activities and inter-relationships of its component parts used to happen anyway"[15]. The TWP was a direct response to problems caused by less than effective co-ordination of process development, registration planning and market forecasting. However, these problems were considerable, and the TWP did not lead to their rapid resolution. This may have been because the structural change was inappropriate - the main difficulty was as much to do with the accuracy of the forecasts of demand and launch dates as the lack of co-ordination between them. Further, there is little evidence in Bower's analysis of the organisational inertia (Warwick, 1975) which might resist change to context and slow its desired effect. The TWP was still defining its role on CAOS when Glaxo's paper on the role of TWP's was circulated more than a year after the first TWP was formed.

Murray's requirement for logistics/planning expertise - leading to the appointment of Frosini - may be viewed as an adjustment of structural context by senior management when the production planning problem became complex. However, this occurred too late to affect the process of facility definition on K2A.

Bower found that a particular problem of context was the lack of interaction across levels of hierarchy which prevented the application of generalist management skills to the capital budgeting problem[16]. Changes to structural context on K2A represent efforts to facilitate this kind of interaction, not only vertically across the hierarchy but, given the widely distributed sources of project definition, horizontally also.

7.5.3 Discussion

The role of top management in the process of definition would appear to be more discernible than in the cases examined by Bower. In those cases, top management appear to have had little say in the choice of particular markets or of products for sale in these markets. Instead, their role is restricted rather more to the adjudication of investment proposals on the basis of aggregate financial criteria.

The corporate phase of the resource allocation process described by Bower does not explicitly accommodate the top management activity of executive appointment which had such a crucial influence on the Dreadnought definition process - and indeed, on the entire project. While top management's response to a discrepancy between the perceived and potential performance of VDS was to appoint Blackmore "to do something" with the business, Blackmore's response was to initiate the re-organisation of VDS and the Dreadnought capital investment project. Although Blackmore was not appointed solely to initiate one capital project, his appointment nevertheless implies an acknowledgement by top management that the initiation of capital projects was a job for divisional management and not for them.

In line with Burgelman (1983) and Marsh *et al* (1988), the case material presented here raises questions as to the appropriateness of determination of context as a tool for top management to influence the behaviour of lower level managers on individual projects. The Vickers context changed prior to the Dreadnought project and facilitated Blackmore's speedy definition and implementation. However, it would appear - as in the case of the decisions examined by Marsh *et al* (1988) - to have been

> "set and determined on a much wider set of considerations"[17]

than the needs of an individual project. Indeed, the more direct role of top management in the definition and impetus processes on both projects compared to those examined by Bower implies that top management had less need to manipulate structural context. Where structural context was changed to facilitate definition - as with the formation of the TWP on K2A - the change was slow to have the desired effect. In this case, managers at a lower level than top management acted to determine their own context when their jobs were directly affected.

7.6 BUILDING AND CHANGING FACILITIES FOLLOWING FUNDING APPROVAL

This part of the analysis is addressed at propositions G, H and I. The focus is therefore on the role of those managers with responsibility as construction client and, in particular, on the management of the definition process following funding approval and on the use of structural context to obtain the facility required. Attention is also paid to how major change - the fallow area - was incorporated on the K2A project.

7.6.1 Proposition G

Proposition G states that:

> All aspects of facility definition - except the limit of expenditure in the investment proposal - may be changed without top management approval.

Most of the changes in facility definition occurring after funding approval concerned detailed design development rather than substantial changes to definition (the major change in respect of the Fallow Area on K2A - which required top management approval - is discussed separately below). It is hardly surprising that none were referred formally to top management for approval or review. Furthermore, there appears to have been none of the kind of informal consultation which occurred between the definers of the project and top management prior to approval. This seems to have been used solely to secure funding approval. The proposition would appear to be supported by the material presented in respect of both cases. More detailed consideration of the absence of top management involvement following funding approval now follows.

Changing technical definition

Although top management approved both proposals - and by implication the definition of facilities contained within them - they had no formal means of ensuring that these facilities would be built as described. The CARs approved only contained an outline of the buildings proposed. Following approval, the role of the facility-oriented managers who defined the discrepancies in the first place was to develop detailed facility designs along the lines set out in the CAR. Top management would only be consulted if such development required additional funds.

This implies that even substantial change could be incorporated following funding approval provided this could be contained within the funding limit approved. The difference between substantial change and detailed design development will vary by firm and by project. The omission of the office accommodation on K2A and the incorporation of ancillary facilities within the main factory envelope on Dreadnought, whilst rather more than detailed design development, did not require top management approval or review. The point, however, is that implementation involves more than simply building that which has been defined in the CAR. In approving the CAR, top management set the broad parameters - primarily of money - within which implementation takes place. In these terms they are not so much approving a project as the purpose of a project. In doing this they would appear to offer lower level managers considerable freedom in deciding what should be built within an expenditure limit. How these lower level managers did this is the subject of proposition H which is discussed below.

Changing financial definition

A distinction was made above between small changes which do not require funding approval and more substantial changes which do. However, the cost of small changes arising from detailed design development, whilst individually not large, may nevertheless accumulate to such an extent that an increase in the funding limit is required. This poses a dilemma for top management who are not involved in the detail of design development. The difficulty here is that - as on Dreadnought - the cumulatively large financial effect of small technical changes may not come to light until late in the project when top management have little choice but to approve the expenditure. (Recall that on Dreadnought the problem was compounded by failure to seek approval for the additional expenditure. The only top management action available was a reprimand.)

Although top management's financial sanction in respect of facility definition is an apparently powerful one, on both of these projects they appeared to have little involvement in the development of definition following approval. On Dreadnought in particular this sanction appears to have been ineffective in ensuring that outturn costs were within the funding limit approved.

7.6.2 Proposition H

Proposition H states that:

> Integrating-level managers with responsibility as construction client will manage the facility definition process to help ensure that the building required is obtained within the limit of funding available.

This is supported by the material presented in respect of both cases. More detailed consideration of this proposition allows an exploration of some implications for those managing the definition process.

The constraint of a funding limit

Those who managed the facility definition process up to the submission of the CAR continued to do so after funding approval. However, as the construction of both facilities progressed, the day-to-day involvement of these managers diminished. Hatfield delegated project management functions to his assistant Laxton; Blackmore relied on Nicholson to deal with routine problems as construction progressed.

It has already been noted that the amount of capital funds likely to be available became known to those concerned with facility definition prior to the formal CAR submission (see section 7.4.2). So although final approval set a limit on the availability of capital resources which in turn constrained the development of facility definition, the definition process was constrained prior to this by information on what was likely to be available.

A firm funding limit was determined earlier on that project - Dreadnought, the larger of the two - where the need for further facility definition following approval was greatest. While K2A approval was preceded by some four months of formal design team meetings and one year of less formal construction industry involvement, that on Dreadnought was preceded by only two months of design development. Furthermore, there was no financial contingency in the cost plan submitted as part of the Dreadnought CAR, whereas in addition to a 2.5 per cent contingency on K2A, costs were permitted to fluctuate within ± 10 per cent of the CAR total. So while both integrating level managers managed facility definition within a funding constraint, there was more of an imperative on Dreadnought for costs not to be exceeded.

Indeed, by obtaining early approval for funding, Blackmore helped ensure that subsequent design development did not cause costs to escalate. The deliberate omission of a contingency - on the grounds that it would have been spent if included - had a similar effect. It has already been noted that both Hatfield and Blackmore used the expenditure limit set - or about to be set - by top management as a cost controlling device, Blackmore most notably in the resolution of the contractor's potential claim.

Availability of finance

In capacity terms it was possible for Blackmore to decide on the scope of facility required early in the definition process; for K2A the identification of capacity required was one of the biggest problems surrounding facility definition. The formal provision for cost escalation is recognition of the uncertain product-market environment within which Glaxo facilities are designed and built. The need to ensure that sufficient capacity would be available was stronger than the need to determine and control an early budget.

Vickers appear to have been more cash-constrained than Glaxo and consequently their need for close cost control may have been greater. The strong element of DTI assistance on Dreadnought and the extent to which the availability of this was an essential part of Executive Committee approval is indicative of this constraint. In contrast, recall that prior to the preparation of the CAR on K2A, Cargill urged Hatfield to avoid

> "short term cost cutting measures simply to meet an initial project capital cost... 'guestimate'."[18]

Whereas the emphasis in facility design on Dreadnought was firmly on costs, on K2A managers appeared more concerned with capacity and quality issues.

7.6.3 Proposition I

Proposition I states that where the likelihood that major change will be needed during construction is high:

> Integrating-level managers with responsibility as construction client will determine a form of structural context between the firm and construction to facilitate the incorporation of this change.

Recall that this form of 'structural context' includes the arrangements between client and construction for the provision of services and work necessary for the delivery of the new building. Given the history of the definition process on K2A and, in particular the extent to which the demand forecasts fluctuated throughout, the likelihood that change would be required was high. Conversely, on Dreadnought, the extent to which Blackmore was able to determine facility sizing early in the process and the low expectation of significant changes in the order situation over the period meant that the likelihood of major change to definition being required during construction was low. So, while on K2A the structural context might be expected to have anticipated the need for change, on Dreadnought - given also the need for close cost control - it might be expected to have specifically excluded it.

The material presented in respect of the K2A project, however, appears not to support this proposition. There was no explicit provision for major change in the formal arrangements between Glaxo and the construction consultants and contractors employed. Furthermore, although market forecasting was expected to continue throughout the construction phase, there was no attempt made to link 'milestones' in the construction process with the timing of market forecasts to allow the opportunity for review which may have enabled change to be accommodated as it arose[19]. On Dreadnought however, there appears to have been a more deliberate attempt to relate the structural context directly to the specific needs of the project. But this was not done to accommodate change and lends little support to proposition I. Rather, it was intended more to exclude change and so enable a speedy completion of construction within a tight cost constraint.

This research was not intended to identify how all client requirements might be accommodated within formal construction contracts and management arrangements. However, consideration of how Glaxo management acted to incorporate the fallow area change in the absence of any prior 'structural' provision helps examine whether the concept of determination of context offers a useful explanation for their actions.

Anticipating change

To examine how change was incorporated on K2A it is necessary to look outside of the formal contractual arrangements between client, consultants and contractors. Of particular significance - given the subsequent fallow area change - was Hatfield's strategy of negotiation with the main contractor, who was also involved in K2. Note that Hatfield's intention was to create an 'atmosphere' of mutual trust within which subsequent change and disruption could be accommodated without delay. Just as key personnel may be appointed to influence the definition and impetus processes, so too may known and trusted consultants and contractors be selected to help provide a ready means of accommodating change. Although this may be viewed as creating a form of 'context' between the client and construction firms, it is arguably a substantially different matter concerning the particular qualities of the actors in the process rather than the organisational or contractual 'structure' within which they operate.

7.6.4 Discussion

Support from the case material for propositions G and H is not surprising. However, it is notable that on both projects, managers with responsibility as construction client used the funding limit set by top management to manage and control facility definition. Conversely, top management, perhaps because of their remoteness from the detailed allocation of resources following funding approval, did not attempt to control the activities of lower level managers by this means. And while expenditure on Dreadnought above the limit authorised in the CAR points to shortcomings in the cost reporting system then in place and highlights the lack of top management control over definition, it is difficult to see how top management could have directly intervened to influence definition by controlling costs in this way.

The formal contractual arrangements played little part in the ease with which the fallow area change was incorporated on K2A. Rather less formal 'structural' factors appear to have been important, including the familiarity of consultants and contractors with Glaxo capital projects and their willingness to maintain good relationships with a large repeat client. Indeed, the familiarity of Hatfield (and Laxton) with the construction process arguably had a greater effect on the choice of procurement method than the likely requirement for change (Nahapiet and Nahapiet, 1985).

Consideration of this change also provides some support for proposition C (ii) (section 7.3.1 above). The fallow area change on K2A - like the change involving the batch plant - arose from a discrepancy identified by managers whose responsibilities rather than their day-to-day tasks were facility-oriented. These managers, because of their seniority, were able to provide the additional impetus required to incorporate this change. However, whereas the batch plant change was founded on a personal technical doubt, the fallow area change arose from a more objective assessment of capacity requirements. Perhaps because of this, and perhaps also because this change was preceded by the batch plant change, the need to incorporate it within the original cost limit was not so great.

Furthermore, the impetus provided to the fallow area change appears rapid and powerful. Chandler moved quickly to take advantage of an opportunity to expand Glaxo Pharmaceuticals' CAOS production capability; this was followed by further rapid impetus in the form of applications for, and approval of, pre-spends to avoid delay to the K2A programme. This lends some support to proposition C (ii) in that the early authorisation of these pre-spends was needed to enable K2A to proceed to programme. The powerful impetus the change attracted was supplemented by changing market conditions which helped clarify the need for the fallow area - recall how easily Parr's opposition to the fallow area application was overcome.

7.7 CONCLUSION

7.7.1 Introduction

The purpose of this research was to use propositions suggested by Bower's resource allocation model to explore key features of the process by which these large manufacturing firms made and implemented capital investment decisions. The inter-case comparison has proved to be a very useful undertaking and the major new insights gained from this exploratory study of the corporate capital investment process allow the problems raised in chapter 1 to be addressed. These problems concern how the firm manages the contribution of construction to facility definition and impetus and how the firm ensures that a suitable new building is obtained.

The study findings have also allowed a consideration of Bower's model as offering a useful conceptual framework for the examination of management action during the decision and implementation stages of investment projects. While it was not the intention of this research to construct a new model of the resource allocation process, important modifications to the conceptual scheme are suggested by the data, in particular regarding the top management role and the use of structural context. For this reason, a brief overall assessment of Bower's model is provided in section 7.8 below. Chapter 8 considers key implications of the research findings and discusses areas for further work.

7.7.2 Key features of the investment process

Two features of the investment projects examined were particularly noticeable. The first was that the main elements of definition and impetus - the 'engine' of corporate capital investment which initiates, defines and moves projects toward funding - resided in the operating divisions of the firms studied (see, for example, Bower, 1970; Burgelman, 1983; Marsh *et al*, 1988). While these elements were largely under the control of managers at division general management level and below, the projects examined arose in response to top management 'stimuli' (King, 1975). Further, top management were kept informed about the development of definition in particular and about the level of funding which would be requested.

The second feature was the central role of the initiators of the facility definition process. They also initiated impetus and undertook the role of construction client, but the critical activity was that of integration during the process of definition. Definition was complex and required integration in financial as well as technical aspects. Whereas integration of the financial aspects of definition tended to occur across the firm's hierarchy, integration of the technical aspects tended to occur more horizontally across the operating level of the organisation and involved contributions from outwith the corporate structure.

7.7.3 Implementation as part of resource allocation

Construction involvement in investment decisions

The central argument developed in chapters 2 and 3 was that implementation is more a continuation of the process of capital investment rather than an end result of it. The idea that the construction industry participates in the capital investment process raises the problem of how the construction contribution is to be managed. And the idea that the firm's requirements may change during the construction process raises the problem of how the firm's management ensures that a suitable new building is obtained. These problems will now be addressed. The participation of construction in the process of facility definition prior to funding approval suggests considerable overlap between the decision and implementation stages. The important consideration is the management of the contribution of the construction industry which in both cases studied was undertaken as an integrating-phase activity as part of the resource allocation process.

Additionally, while expenditure on construction expertise necessary to define and establish the feasibility of new facilities might signal the commencement of implementation before the investment proposal has been formally approved, this is probably necessary in most - if not all - corporate building investment decisions. Of more importance, however, is expenditure on major elements of the work prior to funding approval. This helped considerably on K2A in the provision of impetus and is tangible evidence of support from those managers who approved the expenditure. Moreover, the allocation of funds in this way is an indication both of the extent to which responsibility for resource allocation was delegated from the top management level and of the extent to which implementation may be an essential part of the resource allocation process and not simply an end result of it.

Furthermore, progress with work on facility definition and on preparing for construction between the submission of a funding proposal and its review by top management is further indication that implementation was already well underway prior to funding approval. The conclusion to be drawn is that the decision and implementation stages of the capital investment projects studied are not easily separated, neither in time nor in terms of the nature of the activities undertaken. Rather, these stages are essentially part of the same process of resource allocation; only by viewing management action in terms of this overall process can useful insights be gained into how firms obtain suitable new buildings. Some of the implications of this conclusion are discussed in chapter 8 below.

Construction as an investment process

The notion that the corporate client's role in the construction process is concerned with building that which has been defined in the investment proposal does not receive much support in the data presented in chapters 5 and 6. Indeed, for the two projects studied, the process of definition continued long after funding approval. While this occurred within the funding limit set by top management, it was possible to change financial aspects of definition, both legitimately and through the more or less deliberate neglect of administrative rules and procedures ('structural context'). How the managers of both firms obtained the buildings that they thought were suitable involved elements of the resource allocation process, in particular definition and - to get projects changed - impetus.

The picture of the client within much of the construction management literature as provider of information and authoriser of decisions during the construction process offers little by way of explanation for the integrating roles played by these managers with responsibility as construction client. Seen from the corporate client's perspective, the extent to which these managers sought to ensure that a suitable building was obtained tends to give them a central role in the construction process. Indeed, the firm must manage the construction process as one of continuing resource allocation or accept that the original definer's perception of a discrepancy will constitute the sole definition of building requirements. The way in which the firm's management identify changes in their building requirements, measure these against the building being obtained, seek support and authorisation for any additional capital expenditure and ensure that necessary changes are implemented involves processes of definition and impetus which are essentially part of resource allocation.

Although the formal building contractual arrangements were expected to be constituted specifically to incorporate change in the situation where the likelihood of change was high, the contract was relied on rather more as a mechanism to settle potential disputes on that project where major change was not expected to arise. Although the data here cannot be conclusive, they suggest that the contract may provide a baseline for performance when problems and disagreements arise (Bresnen, 1990) but it may have rather less of a role in the kind of flexible relationships necessary to incorporate major changes. Some of the implications for a consideration of the construction process as part of the process of corporate resource allocation are discussed in chapter 8.

7.7.4 Summary

Before considering the implications of the conclusions drawn for Bower's model, it is appropriate to summarise briefly the main line of discussion developed in this chapter.

The detailed examination of the study propositions helped identify the key features of the process by which the firms studied obtained new facilities. By relating the analysis to other work and, in particular, the resource allocation processes of definition and impetus described in Bower's model, useful explanations were suggested for management action during the decision and implementation stages of the investment projects examined. The largely 'bottom-up' nature of the investment decision and implementation processes was noted. The initiators of definition played a crucial role in managing the construction contribution and in initiating impetus. By focusing on the key integrating role of project initiators it was possible to conclude that, in the cases examined, the decision and implementation stages of corporate capital investment were closely related and that construction was essentially a part of the investment process rather than an end result of it.

7.8 OVERALL ASSESSMENT OF BOWER'S MODEL

7.8.1 Usefulness of the model

The usefulness of Bower's model and the concepts contained within it is demonstrated by the way they have facilitated the analysis of case material.

The model has provided a framework within which to chart capital investment decision making in the firms studied as a 'bottom-up' process and not a "single act of top management deliberation" (see, for example, King, 1975; Marsh *et al*, 1988). Furthermore, the sub-processes of definition and impetus have been particularly useful in examining how the firm's management defined their building requirements and obtained the necessary funding from top management. The idea that each of these sub-processes have different phases (initiating, integrating and corporate) associated with them allowed an examination of the varied contribution made by managers at different levels of the hierarchy, though these phases did not map neatly onto the management hierarchy in either firm studied[20].

The analysis of study findings suggests modifications to Bower's model which are shown diagrammatically in figure 7.2 below. Bower's model at present understates the extent of the integrating-phase task in that it ignores the contribution of construction from outwith the corporate structure. The role of the integrating-phase in definition was especially useful in explaining how construction's contribution to definition was managed as part of the firm's resource allocation process (see figure 7.2).

Those mangers who initiated definition and managed the construction contribution also initiated the impetus processes. 'Impetus' provided a powerful means of examining the forces which moved projects towards funding. This was seen to include elements from outwith the corporate structure such as the requirement for advance capital expenditure prior to formal funding approval. It also helped explain how the firm's management changed facility definition, in that such change required impetus to overcome that already provided and to ensure that changes were implemented, both prior to funding approval and afterwards.

Primarily because on both projects the managers who initiated the definition processes were also responsible for the integrating-phase activities, the distinction between integrating and initiating phases was not so clear. The corporate phase of the definition and impetus processes was, however, distinct and rather more discernible and influential than implied by the model. The role of top management in both projects studied was not easily accommodated within the model and this will now be examined.

7.8.2 Limitations of the model

The argument that discrepancies depend largely on the perception of those identifying them introduces the idea that discrepancies will not automatically be recognised and that some form of external trigger or stimulus (King, 1975) may be needed to start the definition process. The idea that top management may provide such a stimulus is not envisaged in Bower's model but deserves further discussion in the light of the data presented.

The provision within the model for top management involvement - through determination of context - was largely redundant in the analysis as top management did not seek to influence the investment process by this means. An examination of individual projects would appear to provide very limited data on the wider and more general influence of context (Marsh *et al*, 1988). However, the data and the analysis presented do not challenge the notion that structural context is under the control of top management, nor that construction firms may come within a 'structural context' which can be influenced by the firm's management. This part of Bower's model is therefore largely unmodified (see figure 7.2).

The involvement of top management in choosing markets and the products for sale in them (K2A) and in using their power of executive appointment (Dreadnought) was particularly influential in the initiation of the definition processes. These are considerably more direct interventions than is contemplated by determination of context. While the discrepancies leading to facility definition were identified lower down the management hierarchy, there is a sense in which they were in response to a top management 'stimulus'. The data presented strongly suggest that the corporate phase of definition needs to accommodate the ability of top management to stimulate those whose jobs and responsibilities are more facility-oriented to initiate the definition process (see figure 7.2).

Furthermore, whereas the 'corporate phase' of impetus in the model is the review and approval (or rejection) of the investment proposal, in both cases top management contributed impetus at the very least by indicating that investment proposals were expected and were likely to be approved.

Again the data suggest that this phase needs to accommodate a more active top management role in encouraging those proposals they may have stimulated in the first place (and, presumably, discouraging those which are not welcome).

The process of impetus, whilst evident and essential in both cases, appears rather less powerful than in Bowers' analysis. His argument is that investment proposals which are essentially 'bottom-up' require considerable impetus to move them towards funding. In contrast, when top management await a proposal they have helped initiate, the extent of impetus from lower down the hierarchy required to drive it forward and upward is reduced.

In summary, Bower's model provides a useful conceptual framework to explore how the firms studied obtained suitable new buildings as part of the process of resource allocation. Its rich, multi-layered description of the resource allocation process captures management action at different points in time and across different levels of the corporate hierarchy. However, it tends to miss important parts of the processes examined. In particular, by relying on determination of context as a mechanism by which top management can influence the capital investment process, the model effectively ignores a more active top management role which the data suggest needs to be accommodated in the definition and impetus processes.

Figure 7.2 A revised model of resource allocation

Process Phase	DEFINITION Defining the nature and extent of capital investment projects		IMPETUS Getting investment proposals approved and implemented		DETERMINATION OF CONTEXT Determining structure to influence definition, approval and implementation	
CORPORATE	Corporate planning; executive appointment; stimulating ideas for investment projects		Inviting/rejecting outline proposals; final authorisation.		Determining/agreeing structural context	
INTEGRATING	Aggregate financial "Can we afford it?" ↓	↑ Product/Market "How, when, where, and at what cost?"	The company "wants" ↓	↑ The businesses and construction "want"	Corporate needs ↓	↑ Subunit and construction needs
INITIATING	Identifying 'discrepancies' at the level of Products/Markets or individual projects		"This project is worth funding." "This project needs to be changed to make it more worthwhile".		Products/Markets or individual projects not served by structure	

The discussion now turns to consider the key implications of the research findings.

7.9 FOOTNOTES

1 Bower (1970), p81.

2 While the determinants of corporate capital investment and the process by which firms make investment decisions may be closely related, the present study is primarily concerned with the investment process.

3 Bower (1970), pp252-4.

4 RIBA Plan of Work, stages C and D. RIBA (1973).

5 Bower (1970), pp75-6, and see also section 3.2.2 above.

6 Bower (1970), p76.

7 Bower (1970), pp68-71, and see also section 3,2.3 above. Impetus involves managers committing themselves to projects proposed by their subordinates. It is an act - or a series of acts - of managerial judgement, wherein the reputation of sponsoring managers is placed "on the line".

8 See, for example, Fazio, *et al* (1988).

9 Bower (1970), p260.

10 Bower (1970), p54. Note that this is an integrating phase activity in the definition process.

11 Cf Hatfield quote on the roles of Chandler and Parker on the batch plant change, section 5.7.2 above.

12 See section 4.3.3 in chapter 4 for the distinction between business planning and investment planning.

13 Marsh, *et al* (1988), pp35-7. This kind of senior management questioning may force those involved in definition to spend considerable time in either justifying or revising their stance.

14 For a summary of the concept of 'structural context' and the process by which it may be determined, see sections 3.2.4 and 3.2.5 above.

15 Cf Hatfield quote on the origins of the TWP, section 5.6.6 above.

16 Bower (1970). He calls this the "structural specialization problem" (p264).

17 Marsh *et al* (1988), p60.

18 Cf Cargill quote section 5.6.4 above.

19 Walker (1989), pp57-60, and see the discussion in section 2.4.3 above.

20 Nor did they in Bower's analysis:

> "... we are analyzing phases of a complicated task and not counting rungs on a hierarchical chart of organization" (1970; p75).

CHAPTER 8: IMPLICATIONS

8.1 INTRODUCTION AND OVERVIEW

This chapter discusses key implications of the research findings for those who manage the investment process, for those who construct new facilities and for those who wish to study these related processes.

8.1.1 Summary

The study has investigated the decision and implementation stages of capital investment from the corporate perspective in two large UK firms. The background to the research has been the apparent conflict of paradigms between theories of finance and microeconomics - which characterise the corporate investment process in terms of rational choices made between investment alternatives by top management - and empirical studies of the investment process in large firms. These latter studies describe a process of bargaining and choice spread across the corporate hierarchy and over long periods of time.

The rationale for the approach taken has been the lack of attention, in the construction literature in particular, to the way in which corporate clients make and implement capital investment decisions. The research was motivated in part by a belief that an examination of the construction process from the client perspective was long overdue. Moreover, to consider the problems identified, a management approach within a well documented framework would allow for serious exploration of the issues involved. In this way it was also felt that the investigation would make an important contribution to current knowledge concerning how large firms make and implement capital investment decisions.

The main theme has been that the implementation of capital investment decisions is more a continuation of the process of capital investment than it is an end result of it. The examination of the study propositions suggested by the conceptual scheme has provided useful insights into the decision and implementation stages of capital investment projects. The conclusions drawn lend support to the main argument on two broad fronts. First, the involvement of the construction industry early in the decision process required that resources were allocated and commitments made prior to the formal approval of investment projects by top management. The management of construction's contribution was undertaken as an integrating-phase activity by the firm's management as part of resource allocation. Secondly, the corporate client role in the construction process was observed to contain key elements of the definition and impetus processes such that it was possible also to consider this role as part of resource allocation.

8.1.2 Limitations and generalisations

The essentially exploratory nature of the research has already been discussed. Further, the small number of observations mean that a good deal more attention would need to directed at the key features of the resource allocation process identified during this study before firm conclusions could be drawn. Although the findings suggest implications for management, construction and research which are discussed below, it is important first to consider how the settings studied relate to earlier research on corporate capital investment decision making.

The cases investigated were selected to provide contrasting settings for examining the incorporation of change during the construction process. While there was little support for the proposition (I) concerning the extent to which building contractual arrangements might be adjusted in advance to incorporate change where the likelihood of change to facility definition was high - paradoxically, the opposite was found (see sections 7.6.3 and 4 and the discussion in 7.7.3 above) - both the corporate settings and the projects examined were different in a number of other respects. In particular, there were substantial differences between the cases in terms of firms' histories of performance within their industries, their overall strategies and structures, the nature of the products produced and the markets into which these products were to be sold. (These differences are outlined in sections 5.2 and 6.2 and in the commentary on section 6.4.7 above).

While it was not the intention to compare and contrast the cases selected in these terms, the important point here is that the conceptual scheme allowed similarities to be identified in the resource allocation process within these quite disparate settings. Indeed, much of the empirical research into capital investment reported throughout this thesis has avoided such contrasting settings. Bower (1970), for example, examined four cases in different divisions of the one large firm; King (1975) examined two investment decisions in one large firm; Burgelman (1983) examined six new venture projects in one large firm; Bromiley (1986) examined four firms in heavy manufacturing industry. While no attempt is made here to generalise the study findings, the contrasting settings help provide an addition to current knowledge of corporate capital investment.

Furthermore, the differences in setting are also important in their suggestion of likely fruitful directions for further research. For although the similarities of interest were in the key features of the <u>processes</u> investigated, there were differences in the key <u>underlying causes</u> of some of the phenomena reported which may be related to differences in the firms' product/market environments. For example, while it was uncertainties over market requirements - exacerbated by Glaxo's strategy of bringing products to market more quickly than their competitors - which helped complicate the definition and construction processes on K2A, it was the nature of the AFV business - where vehicles are produced in batches to order - which allowed Blackmore to decide early in the definition process on the scope of the Dreadnought facility required. It is not possible to be conclusive with the small number of instances reported here. However, future work could examine the extent to which differences in firm's resource allocation processes could systematically be related to differences in their product market/ environments - and thus identify more precisely which aspects of these environments are relevant.

The discussion now draws together the research findings arising from an examination of the study propositions and considers their key implications. Particular attention is paid to topics which might help identify potentially useful areas for further research.

8.2 IMPLICATIONS FOR MANAGEMENT

Previous studies of the process of resource allocation referred to throughout this text conclude that the process as observed is at odds with, and more complex than, its characterisation in traditional finance theory in particular. Not only do the findings reported here support this description of complexity but, in outlining the involvement of the construction industry in the corporate capital investment process, further complication is introduced. Construction involvement is not generally acknowledged in finance theory nor in empirically based studies of the investment process. On the cases studied this was observed to contribute substantially to the processes of definition and impetus.

8.2.1 The management of definition

In particular, the findings suggest that managers with responsibility as construction client must manage construction's contribution to the process of definition. This would appear to call for generalist skills and knowledge. The task of integrating the need for corporate earnings with the investment needs of individual businesses and further, with questions of what can be built, where, when and at what cost, is an onerous one. At the very least it requires a knowledge of the workings of the corporate organisation at a number of hierarchical levels as well as the detail of the activity to be accommodated in the new building.

Managers react to perceived discrepancies to initiate the definition process. However, such discrepancies are perceived by definers in terms of their job requirements, responsibilities - and indeed, their motivation and goal orientation - and opportunities for action (Mintzberg *et al*, 1976). The point is that discrepancies are not always self-evident problems of capacity, cost or quality, though they may be expressed in these terms. Further research could investigate the problem of identifying and screening investment proposals which mainly serve parochial interests before considerable corporate resources are committed to them.

For those initiating and managing the definition process, the findings suggest that the provision of opportunities for involving senior management may be an important element in the subsequent approval of investment proposals. Further, information about the purpose, scope, and financial content of formal investment proposals all helped to create a receptive atmosphere.

8.2.2 The generation of impetus

The early involvement of construction in the definition process combined with the need for a rapid construction period overall may require that considerable financial resources are committed to corporate capital investment projects in advance of top management funding approval. The findings suggest that, particularly where those managers with responsibility as construction client are also those who initiate the definition process, this requirement may be used to generate impetus to help move investment projects towards ultimate funding.

The more senior the support provided to investment proposals the more difficult it would appear to be for top management to change or reject them. The message for the initiators of investment proposals - particularly those at low levels in the management hierarchy - is to secure sponsorship at the highest hierarchical level possible. Similarly, when definition needs to be changed, support which can overcome the impetus already provided may be necessary.

8.2.3 The top management role

The research did not find that top management altered the corporate structure and rules to influence managerial behaviour on individual investment projects. In the event, they had more direct means at their disposal to stimulate and influence the investment process. In particular, their involvement in corporate-wide business planning can determine the financial and strategic 'context' within which investment proposals are identified and developed. Further, they can appoint key executives to address apparent discrepancies and they can influence the financial content of the definition process in particular by requiring that those developing investment proposals keep them informed of progress.

Indeed, by permitting investment proposals to develop within informal financial limits they may provide tacit approval of proposals well in advance of formal review. The balance to be struck then, would appear to lie between indicating the kind of investment proposals which may be acceptable so as to avoid abortive management effort in definition and impetus, and to maintain sufficient distance not to stifle initiative and to be a less partial adjudicator of proposals than those submitting them.

On the kind of capital projects studied, where detailed design cannot be formulated and frozen in advance of top management review of investment proposals, the funding limit set by top management approval may offer little effective control over the capital expenditure finally committed. A discussion of financial control procedures is beyond the scope of this thesis. However, when cost escalation does not come to light until late in the construction process, top management may have little choice but to approve the additional expenditure. Reprimanding the managers responsible may help avoid a recurrence, but does not guarantee it and does not, of course, redress any financial imbalance caused by the expenditure of additional funds.

8.3 IMPLICATIONS FOR CONSTRUCTION

A central stance of the research is that an examination, from the corporate client's perspective, of how new factory buildings are procured would provide useful new insights into the role of the corporate client in the construction process. The involvement of the corporate client in the process of procuring and constructing new factories has not been much explored in the study of construction management. In addition, there has been little recognition that the process of construction may be viewed as part of the capital investment process.

The research findings suggest that in the development of the discipline of construction management, account may need to be taken of challenges on four broad fronts which up to now have passed largely ignored. These challenges involve:

1. Recognition that the 'engine' of corporate capital investment - which initiates, defines and moves investment projects towards funding - in the large firm is to be found in the operating levels of the organisation;

2. Recognition of the corporate client's need to manage the process of definition as part of resource allocation;

3. Provision for construction's contribution to impetus to help move investment proposals towards funding; and

4. Recognition of the extent to which corporate clients may require an active role during the construction process to ensure that a suitable building is obtained.

8.3.1 Construction involvement in investment decisions

The emphasis within the construction briefing and management literature on the attributes required of those individual managers who undertake the role of corporate client is on seniority, authority and decisiveness. By contrast, the research findings suggest that the generalist and integrative attributes of those managers with responsibility as construction client are also important. The emphasis on these former aspects of the client's role within the construction literature may be misplaced. First, it tends to ignore that the origins of capital investment projects may be located deep within the operating divisions of large firms. Secondly, the requirement for decisiveness effectively ignores the process of bargaining and choice spread across the corporate hierarchy and over time which characterises capital investment decision making in the large firms studied.

While construction briefing may be defined as the process of eliciting the requirements of clients to enable buildings to be designed (Kelly *et al*, 1992), this implies a largely uni-directional flow of information during the process of definition. However, the findings suggest that corporate clients also elicit information from construction which is crucial to the client's definition of building requirements and concerns what can be built, in what timescale and at what cost. Furthermore, the corporate client manages this flow of information and integrates it into the definition process. In this way construction participates in the process of resource allocation rather than 'taking a brief' from a client who has already decided to build. This implies that construction may be in a position to influence the nature and direction of corporate capital investment. This deserves to be explored in further research. At the very least, construction has an interest - and a potentially important role - in helping to progress capital investment proposals towards funding.

This line of argument is given further support from the research findings by a consideration of the important contribution construction may make to generate impetus. Although managers with responsibility as construction client may use the requirements of rapid construction especially to require expenditure in advance of top management approval, the role of construction in helping to initiate this needs to be explored further.

8.3.2 Construction as an investment process

The perspective taken on the present research has tended to give the client a more prominent and central role in the construction process than is conventionally acknowledged in much of the construction literature. The focus on major change occurring during construction raises a number of implications for those concerned with construction management. The first is the importance of taking a view of construction as part of the wider process of resource allocation. The findings suggest that a greater awareness of the corporate client's need to monitor its requirements during the construction process and to measure changes against the scope of the building being constructed may need to be developed.

Further, the findings suggest that such an awareness might be complemented by a positive attitude towards change on the part of construction consultants and contractors. Indeed, this attitude may be as important as - if not more than - specific contractual provisions which attempt to anticipate and accommodate future change. Although problems on construction projects are often attributed to the introduction of major change during the process, it may be hoped that an awareness of construction as a continuation of resource allocation rather than an end result of it may lead eventually to a more tolerant and accommodating stance.

The construction industry, as participant in the investment process, may introduce change to building definition but must - like those managers initiating definition - secure sponsorship from within the corporate organisation to provide the necessary impetus. Indeed, an awareness of the importance and potential sources of impetus may be an important prerequisite for the initiation of change.

The extent to which the project funding limit may be set early in the investment decision process - as a result of negotiation with corporate top management prior to formal funding submission and approval - brings into sharp focus the importance of cost estimating/planning as an essential tool in the resource allocation process. Further, the reluctance of managers with responsibility as construction client to request additional funds from top management - even prior to funding approval - suggests that detailed design development may involve considerable re-allocation of available funds. Although practitioners are likely to be familiar with this problem, it is rather counter to the rational and orderly notion of design development and cost planning presented in many standard texts.

8.4 IMPLICATIONS FOR RESEARCH

The particular orientation of this research was motivated partly by the fact that few studies of the building process undertaken up to now have focused on the corporate client's perspective. The study has demonstrated the usefulness of this perspective for a consideration of two problems for the large firm in making and implementing industrial building investment decisions. The first of these problems concerned the contribution of the construction industry to the investment decision process. The second concerned how the firm's management ensured that a suitable new building was obtained. By considering these problems as part of the wider corporate problem of resource allocation, it was possible to utilise a conceptual scheme which directed attention at key features of the investment process. By beginning to chart the research territory in this way, the study suggests a potentially rewarding approach for further investigation of the corporate client's role in construction.

This is important because the research, as befits an exploratory study, raises considerably more questions than it provides answers. Before turning to a discussion of some of the key questions raised by the research and suggestions for further work, it is appropriate first to address briefly some questions of approach and methodology.

The use of the case study method on studies of building projects is neither as widespread nor as developed as its use in management studies and in the business administration area generally. More particularly, case histories and historical methods of data collection are relatively uncommon in studies involving construction. This research illustrates that completed construction projects may provide a potentially large source of research data which would help extend and develop the findings reported here.

Additionally, a most useful focus for future research would be on developing and refining the concepts of management action - in particular, integration and impetus - which have proved useful in helping to understand of the client's role in the cases reported. Consideration of the task of integration and the process of impetus raise questions of extent or degree. Further important methodological questions of measurement then arise. Whilst these cannot be considered fully here, it may be noted that both the need for integration and the process of impetus were observed to vary between the cases studied; yet the extent to which these can vary remains a wide open question. Future work could focus more closely on these elements of the resource allocation process in a range of settings so that definitions could be made operational and variability could be studied.

This research arose from a number of distinct but related lines of enquiry spanning a range of academic disciplines, and it is appropriate that questions raised for further work are equally wide ranging. Key suggestions for research are discussed below under the headings of corporate capital investment, studies of organisation, factories as inputs to production and construction management.

8.4.1 Questions for corporate capital investment

The inter-case comparison revealed differences in the extent to which aspects of the firm's product/market strategies may either conflict with or facilitate the management of the resource allocation process. Glaxo's strategy of bringing products to market quickly by "time compression in the development phase" created problems for those concerned with facility definition in particular. The question arises as to whether these kinds of conflicts are important in the formulation of strategy - at the heart of the notion of competitive advantage (Porter, 1985) is that ideas must be feasible and capable of implementation.

The contrasting settings examined raise questions about a contingency approach to corporate capital investment related to differences in firm's product/market environments. Further research in a range of carefully selected settings could help investigate the effect of product/market environment more fully, in particular the extent to which environment uncertainty influences the definition process.

The contrast in the findings reported here and those reported by Bower (1970) between the extent of top management involvement in the capital investment process suggests potentially fruitful areas for further research. In particular, the mechanisms for top management participation and how they help initiate the definition process are worthy of further exploration, as well as how they control or influence the investment process following formal funding approval. In this latter case the argument that implementation is part of the investment process and not an end result of it is particularly apposite. Following funding approval there is still a lot of resource allocation left to do. How top management control this is not at all clear.

The importance of the allocation of managerial resources as a top management activity raises questions about the kind of managerial qualities required to manage resource allocation. Further, it suggests that a theory of corporate capital investment which accommodates the human and organisational processes observed may also require a theory of executive selection.

Finally, the origins of investment projects and, in particular, the nature of the discrepancies which give rise to project definition and the conditions under which they arise are especially interesting. Indeed, concern about these aspects of capital investment projects may be expected from top management as well as those whose corporate careers may be helped by initiating successful investment projects.

8.4.2 Questions for studies of organisation

The key question for studies of organisation is the extent to which the corporate structure may be designed and adjusted to influence the resource allocation process. Whilst little support is forthcoming from the findings presented here for the adjustment of the organisational structure to influence behaviour on individual projects, further research could pay attention to appropriate structures for resource allocation. In particular, given the importance of impetus to the investment process, the extent to which this may be facilitated by the organisational structure is a most interesting question.

Additionally, a greater range of cases could provide opportunities for examining the effects on resource allocation of corporate climate and culture (Deal and Kennedy, 1988) more explicitly than was possible on the present study. Indeed, the contrasts between the cases presented suggest that this may provide a particularly profitable line of enquiry.

8.4.3 Questions for factories as inputs to production

It was argued in chapter 1 that the treatment of factory buildings as inputs to production was somewhat problematic within microeconomic theory. The way in which the capacity of the production facilities required on both cases was determined does not fit neatly into the orthodox microeconomic framework, which implies that factories are subject to the same marginal adjustments as other factors of production. At the very least, the data implies that there is an element of 'slack' - ie the existence of extra resources beyond what are needed to perform efficiently and effectively the required task (Cyert and March, 1963) - in firms' definitions of their factory building requirements. Both firms studied planned for capacity additional to anticipated requirements. However, such questions are well beyond the scope of this thesis, and it is left to further research to explore the implications of this for economic theory in particular.

8.4.4 Questions for construction management

The key implication for further construction management research is that a consideration of the client - and in particular the corporate client - perspective is required in studies of construction briefing, procurement and management. The call for greater awareness of clients' needs and constraints would appear to coincide with the growing emphasis placed on market factors throughout UK industry in the latter part of the 1980s and the early 1990s. Indeed, the emphasis within construction management research has arguably shifted in recent years onto a consideration of arrangements and procedures which will better serve the industry's clients. However, much remains to be done.

A key question to be investigated is the extent to which the emphasis in the construction literature on the single authoritative and decisive client tends to miss important aspects of how corporate clients in particular make decisions to invest in new buildings. First, it is to be hoped that further work will broaden the research base identified here by examining the client's role on construction projects as part of capital investment and in a variety of commercial and, indeed, social settings. Secondly, particular attention could usefully be paid to the way in which corporate client requirements are formulated and articulated to the construction industry, and the industry's role in this.

Thirdly, research could examine the stages in the more conventional models of building design development (for example, the RIBA Plan of Work) when definers of corporate capital investment proposals seek funding from top management. In particular, the implications of financial limits on design development - from both the corporate and the construction perspective - need to be more fully explored.

And fourthly, the means of facilitating major change during the construction process require to be investigated, concentrating on both formal contractual provisions and the attitudes of those who must determine and administer them. The more general point is that while many construction problems are attributed to the introduction of major change during the process, the challenge of accommodating such change has not yet been fully addressed.

Finally, it is hoped that the research reported here will suggest potentially valuable areas for further work which will contribute to the large and growing body of empirical and theoretical research in both corporate capital investment and construction management. Indeed, this research implies strongly that an awareness of construction needs to be brought into research on capital investment decision making, just as an awareness of the process of corporate capital investment is required in construction management research.

REFERENCES

Ackerman, R.W. (1968). *Organization and the Investment Process: A Comparative Study*, Unpublished doctoral dissertation, Graduate School of Business Administration, Harvard University, Boston.

Ackerman, R.W. (1970). 'Influence of integration and diversity on the investment process', *Administrative Science Quarterly*, September, pp341-351.

Adler, P.S., Shenhar, A. (1990). 'Adapting your technological base: The organizational challenge', *Sloan Management Review*, **32** (1), pp25-37.

Aharoni, Y. (1966). *The Foreign Investment Decision Process*, Division of Research, Graduate School of Business Administration, Harvard University, Boston.

Allen, D. (1984). 'Towards the client's objective', in *Quality and Profit in Building Design*, Brandon, P., Powell, J.A. (eds), E&FN Spon, London.

Allison, G.T. (1969). 'Conceptual models and the Cuban missile crisis', *American Political Science Review*, **63** (3), pp689-718.

Archibald, G.C.(ed) (1971). *The Theory of the Firm*, Penguin, Harmondsworth.

Arrow, K. (1951). *Social Choice and Individual Values*, Cowles Commission, Monograph 12, John Wiley & Sons, New York.

Ashworth, A. (1986). *Contractual Procedures in the Construction Industry*, Longman, London.

Banwell, H. (1964). *The Placing and Management of Contracts for Building and Civil Engineering Work. A report of the committee under the chairmanship of Sir Harold Banwell*, HMSO, London.

Bart, C.K. (1986). 'Product strategy and formal structure', *Strategic Management Journal*, **7**, pp293-312.

Barwise, T.P., Marsh, P.R., Wensley, J.R.C. (1987). 'Strategic investment decisions', *Research in Marketing*, **9**, pp1-57.

Baumol, W.J. (1967). *Business Behavior, Value and Growth*, Revised (2nd) edn. Harcourt, Brace & World, New York.

Baumol, W.J., Stewart, M. (1971). 'On the behavioral theory of the firm', in *The Corporate Economy*, Marris, R., Wood, A. (eds), pp118-143. Macmillan, London.

Bennett, J. (1991). *International Construction Project Management: General Theory and Practice*, Butterworth Heinemann, Oxford.

Berg, N.A. (1963). *The Allocation of Strategic Funds in a Large Diversified Industrial Company*, Unpublished doctoral dissertation, Graduate School of Business Administration, Harvard University, Boston.

Berle, A.A., Means, G.C. (1932). *The Modern Corporation and Private Property*, Macmillan, New York.

Berry, A.J. (1976). *Control of Investment Process in a Large Enterprise*, Unpublished doctoral dissertation, University of Manchester.

Berry, A.J. (1984). 'The control of capital investment', Journal of Management Studies, **21** (1), pp61-81.

Bettis, R.A. (1983). 'Modern financial theory, corporate strategy and public policy: Three conundrums', *Academy of Management Review,* **8**, pp406-15.

Bettis, R.A., Prahalad, C.K. (1983). 'The visible and the invisible hand: resource allocation in the industrial sector', *Strategic Management Journal,* **4**, pp27-43.

Betts, M., Ofori, G. (1992). 'Strategic planning for competitive advantage in construction', *Construction Management and Economics,* **10**, pp511-532.

Bierman, H., Smidt, S. (1988). *The Capital Budgeting Decision: Economic Analysis of Investment Projects*, 7th edn. Macmillan, New York.

Bon, R. (1989). *Building as an Economic Process: An Introduction to Building Economics*, Prentice Hall, Englewood Cliffs, N.J.

Bourgeois, L.J. (III). Eisenhardt, K.M. (1988). 'Strategic decision process in high velocity environments: Four cases in the microcomputer industry', *Management Science,* **34** (7), pp816-835.

Bower, J.L. (1970). *Managing the Resource Allocation Process*, Harvard Business School Press, Boston.

Bower, J.L., Doz, Y. (1979). 'Strategy formulation: A social and political review', in *Strategic Management*, Schendel, D.E., Hofer, C.W. (eds). pp152-166., Little Brown, Boston.

Brandon, P., Basden, A., Hamilton, I., Stockley, J. (1988). *Expert Systems: The Strategic Planning of Construction Projects*, The RICS/Alvey Research for chartered quantity surveyors, RICS, London.

Brandon, P.S., Powell, J.A. (eds) (1984). *Quality and Profit in Building Design*, E&FN Spon, London.

Braybrooke, D., Lindblom, C.E. (1963). *A Strategy of Decision*, The Free Press, New York.

Bresnen, M.J. (1986). *A Study of Forms of Project Organisation and Matrix Management: Case Studies from the Construction Industry*, unpublished PhD thesis, University of Nottingham.

Bresnen, M.J. (1988). 'Insights on site: research into construction project organizations', in *Doing Research in Organizations*, Bryman, A. (ed), pp34-52, Routledge, London.

Bresnen, M.J. (1990). *Organising Construction: Project Organisation and Matrix Management*, Routledge, London.

Bresnen, M.J. (1991). 'Construction contracting in theory and practice: A case study', *Construction Management and Economics*, **9**, pp247-263.

Bresnen, M.J., Haslam, C.O. (1991). 'Construction industry clients: A survey of their attributes and project management practices', *Construction Management and Economics*, **9**, pp327-342.

British Property Federation (1983). *Manual of the BPF System: The British Property Federation System for Building Design and Construction*, The British Property Federation, London.

Bromiley, P. (1986). *Corporate Capital Investment: A Behavioral Approach*, Cambridge University Press, Cambridge.

Bryant, D.T., MacKenzie, M.R., Amos, W. (1969). *The Role of the Client in Building*, Document No. IOR/335/2, Tavistock Institute of Human Relations, London.

Bryman, A. (ed) (1988). *Doing Research in Organizations*, Routledge, London.

Bryman, A., *et al* (1988). 'The contribution of client attitudes, organisation and expectations to performance on construction sites', *SERC Final Report No. GR/D/6480.3*, Science and Engineering Research Council, Swindon.

Building (Various). 'Contract News Service', The Builder Group, London.

Building Services Research and Information Association (BSRIA) (1990). *A Design Briefing Manual (Application Guide 1/90)*, BSRIA, Bracknell.

Burgelman, R.A. (1983). 'A Process Model of Internal Corporate Venturing in the Diversified Major Firm', *Administrative Science Quarterly*, **28**, pp223-244.

Burns, T., Stalker, G.M. (1961). *The Management of Innovation*, Tavistock Publications, London.

Burrell, G., Morgan, G. (1979). *Sociological Paradigms and Organisational Analysis*, Heinemann, London.

Butler, R., Davies, L., Pike, R., Sharp, J. (1991). 'Strategic investment decision making: Complexities, politics and process', *Journal of Management Studies*, **28** (4), pp396-415.

Butler, R., Davies, L., Pike, R., Sharp, J. (1993). *Strategic Investment Decisions: Theory, practice and process*, Routledge, London.

Cannon, C.M. (1968). 'Private capital investment: A case study approach towards testing alternative theories', *Journal of Industrial Economics,* **16**, pp186-195.

Carter, E.E. (1971). 'The behavioral theory of the firm and top level corporate decisions', *Administrative Science Quarterly,* **16**, December, pp413-428.

Central Statistics Office (1986). *Standard Industrial Classification*, Revised 1980, HMSO, London.

Central Statistics Office (1990). *Acquisitions and Mergers by Industrial and Commercial Companies*, Business Monitor MQ7 (Quarterly), HMSO, London.

Central Statistics Office (1992). *United Kingdom National Income Accounts* (The Blue Book). 1992 edition, HMSO, London.

Centre for Advanced Land Use Studies (CALUS) (1979). *Buildings for Industry*, CALUS Research Report, Centre for Advanced Land Use Studies, College of Estate Management, Reading.

Centre for Advanced Land Use Studies (CALUS) (1984). *Development for High Technology*, CALUS Property Studies, Centre for Advanced Land Use Studies, College of Estate Management, Reading.

Centre for Strategic Studies in Construction (1991). *Construction Management Forum: Report and Guidance*, University of Reading, Reading.

Chandler, A.D.(Jr.) (1962). *Strategy and Structure*, MIT Press, Cambridge, Mass.

Channon, D.F. (1973). *The Strategy and Structure of British Enterprise,* Reprinted 1979, Macmillan, London.

Chartered Institute of Building (1980). *Building for Industry and Commerce: Client Guide*, Chartered Institute of Building, Ascot.

Chartered Institute of Building (1988). *Project Management in Building,* 3rd edn., Chartered Institute of Building, Ascot.

Chenall, R., Morris, D. (1991). 'The effect of cognitive style and sponsorship bias on the treatment of opportunity costs in resource allocation decisions', *Accounting Organizations and Society,* **16** (1), pp27-46.

Cherns, A.R., Bryant, D.T. (1984). 'Studying the client's role in construction management', *Construction Management and Economics,* **2**, pp177-184.

Cohen, M.D., March, J.G., Olsen, P.J. (1972). 'A garbage can model of organizational choice', *Administrative Science Quarterly,* **17**, pp1-25.

Cohen, W.M. (1983). 'Investment and industrial expansion: A corporate variables framework', *Journal of Economic Behavior and Organization,* **4**, pp91-111.

Collier, B. (1980). *Arms and the Men: The Arms Trade and Governments,* Hamish Hamilton, London.

Company Reporting (1992). *The UK R&D Scoreboard*, Company Reporting Limited, Edinburgh.

Construction News (Various). 'Business Leads', Construction Publications, London.

Contract Journal (Various). 'Business Alert', Reed Business Publications, London.

Copeland, T.E., Weston, J.F. (1983). *Financial Theory and Corporate Policy*, 2nd edn., Addison-Wesley, Reading, Mass.

Crew, M.A. (1975). *Theory of the Firm*, Longman, London.

Crichton, C. (1966). *Interdependence and Uncertainty: A Study of the Building Industry*, Tavistock Publications, London.

Crompton, R., Jones, G. (1988). 'Researching white collar organizations: Why sociologists should not stop doing case studies', in *Doing Research in Organizations*, Bryman, A. (ed), pp68-81., Routledge, London.

Cubbin, J., Leech, D. (1983). 'The effect of shareholding dispersion on the degree of control in British companies: Theory and measurement', *Economic Journal*, 93 June, pp351-369.

Curwen, P.J. (1974). *Managerial Economics*, Macmillan, London.

Cyert, R.M., Hedrick, C.L. (1972). 'Theory of the firm: Past, present and future; an interpretation', *Journal of Economic Literature,* **10** (2), pp398-409.

Cyert, R.M., March, J.G. (1963). *A Behavioral Theory of the Firm*, Reprinted 1970, Prentice-Hall, Englewood Cliffs, N.J.

Cyert, R.M., Simon, H.A. (1983). 'The behavioral approach with emphasis on economics', *Behavioral Science,* **28**, pp95-108.

Davies, S., Geroski, P.A., Lund, M., Vlassopoulos, A. (1991). *The Dynamics of Market Leadership in the UK Manufacturing Industry 1979-1986,* Centre for Business Strategy, London Business School, London.

Deal, T.E., Kennedy, A.A. (1988). *Corporate Cultures: The Rites and Rituals of Corporate Life*, Penguin, London.

Department of Construction Management, (1989). *Profile of research projects undertaken within the Specially Promoted Programme in Construction Management*, Department of Construction Management, University of Reading, on behalf of the Science and Engineering Research Council.

Department of the Environment (1986). *Accommodation Needs of Modern Industry: Final Report - Summary of Findings*, Department of the Environment, London.

Department of the Environment (1992). *Housing and Construction Statistics: Great Britain* (Quarterly). HMSO, London.

Department of the Environment and the Department of Industry (1982). *The United Kingdom Construction Industry: A guide to methods of obtaining a new industrial building in the UK*, DOE and DOI, London.

Dodd, J., Langford, D.A. (1990). 'Construction management on one large project in London: A case study', *Construction Management and Economics*, **8**, pp385-398.

Doz, Y. (1980). 'Strategic Management in Multinational Companies', *Sloan Management Review*, Winter, pp27-46.

Drury, J. (1981). *Factories: Planning, design and modernisation*, Architectural Press, London.

Dunkerley, D. (1988). 'Historical methods and organization analysis: The case of a naval dockyard', in *Doing Research in Organizations*, Bryman, A. (ed), pp82-95., Routledge, London.

Eccles, R.G. (1981). 'The quasifirm in the construction industry', *Journal of Economic Behavior and Organization*, **2**, pp335-357.

Economist (1989). Shell game, September 23, pp115-6.

Economist (1989a). Making Rover fly, December 9, pp29-30.

Emmerson, H. (1962). *Survey of Problems Before the Construction Industries, A report prepared for the Ministry of Works by Sir Harold Emmerson*, HMSO, London.

European Construction Institute (1991). *Client management and its role in the limitation of contentious claims, Report of the Client Management Task Force, Publication TF003/1*, The European Construction Institute, Loughborough.

Fayol, H. (1949). *General and Industrial Management* (Translated C.Storr), Pitman, London.

Fazio, P., Moselhi, O., Theberge, P., Revay, S. (1988). 'Design impact of construction fast track', *Construction Management and Economics*, **6**, pp195-208.

Fielding, N.G., Fielding, J.L. (1986). *Linking Data*, Sage University Paper series on Qualitative Research Methods, Vol 4, Sage Publications, Beverly Hills, California.

Fornell, C. Lorrange, P., Roos, J. (1990). 'The Cooperative Venture Formation Process: A Latent Variable Structural Modelling Approach', *Management Science,* **36** (10), pp1246-1255.

Foss, C.F., McKenzie, P. (1988). *The Vickers Tanks*, Patrick Stephens Ltd, Wellingborough.

Fothergil, S., Monk, S., Perry, M. (1987). *Property and Industrial Development*, Hutchinson, London.

Franks, J. (1990). *Building Procurement Systems*, 2nd edn. Chartered Institute of Building, Ascot.

Galbraith, J.K. (1967). *The New Industrial State*, Hamish Hamilton, London.

Galbraith, J.R. (1973). *Designing Complex Organizations,* Addison -Wesley, Reading, Mass.

Galbraith, J.R. (1977). *Organization Design*, Addison-Wesley, Reading, Mass.

Gardiner, P.D., Simmons, J.E.L. (1992). 'Analysis of conflict and change in construction projects', *Construction Management and Economics,* **10**, pp459-478.

Glaxo Corporate Communications Department. (1990). *Glaxo Facts and Figures 1990*, Glaxo Holdings, London.

Glaxo Holdings Plc. (1986). *Annual Report and Accounts: Year ended 30 June 1986*, Glaxo Holdings, London.

Glaxo Holdings Plc. (1990). *Annual Report and Accounts*, Glaxo Holdings, London.

Glaxo Manufacturing Services (1986). *40 Years: Penicillin Production at Barnard Castle 1946-1986*, Glaxo Manufacturing Services Ltd, Barnard Castle, Durham.

Goodacre, P., Murray, J., Pain, J., Noble, B.M. (1982). *A Design/Cost Theory for Measuring Buildings*, Occasional Paper No 1, Department of Construction Management, University of Reading, Reading.

Goold, M., Campbell, A. (1987). *Strategies and Styles: The Role of the Centre in Managing Diversified Corporations*, Basil Blackwell, Oxford.

Grant, R., Jamine, A., Thomas, H. (1986). *Diversification and Profitability: A study of 305 British manufacturing companies,* Working Paper Series, No. 25, December, Centre for Business Strategy, London Business School, London.

Grant, R., Jamine, A., Toker, S. (1986). *Diversification Strategy and Firm Performance in British Manufacturing Industry*, Working Paper Series, no. 9 June, Centre for Business Strategy, London Business School, London.

Gupta, A.K., Govindarajan, V. (1991). 'Knowledge flows and the structure of control within multinational corporations', *Academy of Management Review,* **16** (4), pp768-792.

Hakim, C. (1987). *Research Design: Strategies and Choices in the Design of Social Research,* Allen and Unwin, London.

Hammersley, M., Atkinson, P. (1983). *Ethnography: Principles in Practice,* Tavistock Publications, London.

Hannah, L. (1983). *The Rise of the Corporate Economy,* 2nd edn, Methuen, London.

Hannah, L., Kay, J.A. (1977). *Concentration in Modern Industry: Theory, Measurement and the UK Experience,* Macmillan, London.

Harris, F., McCaffer, R. (1989). *Modern Construction Management,* BSP Professional Books, Oxford.

Hickson, D.J., Butler, R.J., Gray, D., Mallory, G.R., Wilson, D.C., (1986). *Top Decisions: Strategic Decision-Making in Organizations,* Blackwell, Oxford.

Higgin, G., Bryant, D.T., Jessop, N., Luckman, J., Stringer, J. (1965). *Building Industry Communications Research Project: Realisation Report, Doc. T.592,* Tavistock Publications, London.

Higgin, G., Jessop, N. (1965). *Communications in the Building Industry,* Tavistock Publications, London.

Hill, C.W.L. (1988). 'Corporate control type, strategy, size and financial performance', *Journal of Management Studies,* **25** (5), pp403-417.

Hillebrandt, P.M., Cannon, J. (eds) (1989). *The Management of Construction Firms: Aspects of Theory,* Macmillan, London.

Hillebrandt, P.M., Cannon, J. (1990). *The Modern Construction Firm,* Macmillan, London.

HM Treasury (1985). *Capital Expenditure Contracts: Pilot Study by the Efficiency Unit* (The Ibbs Report), HM Treasury, London.

HM Treasury (1986). *Working Group on Capital Expenditure Contracts: Final Report* (The Spackman Report), HM Treasury, London.

HM Treasury (1989). *No. 12 Contracts and Contract Management for Construction Works*, Central Unit on Purchasing Guidance, HM Treasury, London.

HM Treasury (1992). *No. 33 Project Sponsorship*, Public Competition and Purchasing Unit Guidance, HM Treasury, London.

HM Treasury (1992a). *No. 36 Contract Strategy Selection for Major Projects,* Central Unit on Purchasing Guidance, HM Treasury, London.

Hofer, C.W. (1976). 'Research on strategic planning: A survey of past studies and suggestions for future efforts', *Journal of Business and Economics,* **28**, pp261-286.

Industrial Building Bureau (1984). *Toward Improved Industrial Building,* Industrial Building Bureau, London.

Institute of Directors (1962). *Better Factories,* Institute of Directors, London.

Ireland, R.D., Hill, M.A., Bettis, R.A., De Porras, D.A. (1987). 'Strategy formulation processes: differences in perceptions of strength and weakness indicators and environmental uncertainty by managerial level', *Strategic Management Journal,* **8**, pp469-485.

Ireland, V. (1985). 'The role of managerial actions in cost, time and quality performance of high rise commercial building projects', *Construction Management and Economics,* **3**, pp59-87.

Istvan, D.E. (1961). *Capital Expenditure Decisions,* Bureau of Business Research, Indiana University, Indiana.

Jones, S. (1985). 'Depth interviewing', in *Applied Qualitative Research,* Walker, R.(ed), pp45-55., Gower, Aldershot.

Jones, S. (1985a). 'The analysis of depth interviews', in *Applied Qualitative Research,* Walker, R.(ed), pp56-70., Gower, Aldershot.

Katz, D., Kahn, R.L. (1978). *The Social Psychology of Organisation,* 3rd edn., Wiley, New York.

Kelly, J., MacPherson, S., Male, S. (1992). *The Briefing Process; A Review and Critique,* RICS Research Papers, Paper number 12, Royal Institution of Chartered Surveyors, London.

Kelly, J., Male, S. (1991). *Value Management: Enhancing value or cutting costs?,* RICS Occasional Paper, Surveyors Publications, London.

Kennedy, J.A., Sugden, K.F. (1986). 'Ritual and reality in capital budgeting', *Management Accounting,* February, pp34-37.

King, P. (1975). 'Is the emphasis of capital budgeting theory misplaced?', *Journal of Business Finance and Accounting,* **2** (1), pp69-82.

King, P.F. (1975a). *An Investigation of the Process of Large Scale Capital Investment Decision Making in Diversified Hierarchical Organizations,* Unpublished doctoral dissertation, Cambridge University.

Klammer, T. (1972). 'Empirical evidence of the adoption of sophisticated capital budgeting techniques', *Journal of Business,* **45** (3), pp387-397.

Langford, D.A., *et al* (1987). 'An expert system to advise industrial clients (continuation study)', *SERC Final Report No. GR/D/3754.8*, Science and Engineering Research Council, Swindon.

Langford, D.A., Male, S.P. (1991). *Strategic Management in Construction,* Gower, Aldershot.

Lansley, P., Quince, T., Lea, E. (1979). *Flexibility and Efficiency in Construction Management,* Ashridge Management Research Unit, Berkhamsted.

Laufer, A. (1990). 'Decision-making roles in project planning', *Journal of Management in Engineering,* **6** (4), pp416-430.

Laufer, A. (1992). 'A micro view of the project planning process', *Construction Management and Economics,* **10**, pp31-43.

Lawrence, P.C., Lorsch, J.W. (1967). *Organisation and Environment: Managing Differentiation and Integration,* Harvard University Press, Boston, Mass.

Levy, H., Sarnat, M. (1986). *Capital Investment and Financial Decisions*, 3rd edn, Prentice Hall, Englewood Cliffs, N.J.

Loasby, B.J. (1971). 'Hypothesis and paradigm in the theory of the firm', *Economic Journal,* **81** December, pp863-885.

Lorrange, P. (1972). *Behavioral Factors in Capital Budgeting,* Universitetsforlaget, Bergen, Norway.

Lorrange, P. (1979). 'Formal planning systems: Their role in strategy formulation and implementation', in *Strategic Management: A New View, of Business Policy and, Planning*, Schendel, D.E., Hofer, C.W. (eds), Little, Brown and Co., pp226-241., Boston.

Lupton, T. (1971). *Management and the Social Sciences*, 2nd edn, Penguin, Harmondsworth.

Machlup, F. (1967). 'Theories of the firm: Marginalist, behavioral, managerial',*American Economic Review,* **57** March, pp1-33.

Mackinder, M., Marvin, H. (1982). *Design Decision Making in Architectural Practice,* Research Paper No. 19, Institute of Advanced Architectural Studies, University of York, York.

Male, S.P., Kelly, J.R. (1989). 'Organisational responses of public sector clients in Canada to the implementation of value management: Lessons for the UK construction industry', *Construction Management and Economics,* **7** (3), pp203-216.

Male, S.P., Stocks, R.K. (1991). *Competitive Advantage in Construction,* Butterworth Heinemann, Oxford.

March, J.G., Simon, H.A. (1958). *Organisations*, John Wiley, New York.

Marris, R. (1964). *The Economic Theory of Managerial Capitalism,* Macmillan, London.

Marris, R. (1971). 'An introduction to theories of corporate growth', in *The corporate economy*, Marris, R., Wood, A. (eds), pp1-36, Macmillan, London.

Marsh, P., Barwise, P., Thomas, K., Wensley, R. (1988). *Managing Strategic Investment Decisions in Large Diversified Companies,* London Business School, Centre for Business Strategy, London.

McIntyre, A.D., Coulthurst, N.J. (1985). 'Theory and practice in capital budgeting with particular reference to medium-sized UK companies', *The British Accounting Review,* **17** (2), pp24-70.

Merrett, A.J., Sykes, A. (1973). *The Finance and Analysis of Capital Projects*, 2nd edn, Longman, London.

Miles, R.H., Snow, C.C. (1978). *Organizational Strategy, Structure and Process*, New York.,

Ministry of Public Building and Works (MOPBW) (1965). *Preparing to Build, R&D Building Management Handbook 1,* HMSO, London.

Mintzberg, H. (1979). *The Structuring of Organizations,* Prentice Hall, Englewood Cliffs, N.J.

Mintzberg, H., Raisinghani, D., Theoret, A. (1976). 'The structure of unstructured decision processes', *Administrative Science Quarterly,* June, **21**, pp246-257.

Mitchell, J.C. (1983). 'Case and situation analysis', *Sociological Review,* **31** (2), pp187-211.

Morgan, G. (1986). *Images of Organization*, Sage, London.

Morris, P.W.G. (1973). 'Organizational analysis of project management in the building industry', *Build International,* **6** (6), pp595-616.

Morris, P.W.G. (1982). 'Managing project interfaces - key points for project success', in *Project Management Handbook*, Cleland, D.I., King, W.R. (eds), Van Nostrand Reinhold, New York.

Morris, P.W.G., Hough, G.H. (1987). *The Anatomy of Major Projects: A Study of the Reality of Project Management*, John Wiley & Sons, Chichester.

Nahapiet, H., Nahapiet, J. (1985). 'A comparison of contractual arrangements for building projects', *Construction Management and Economics,* **3**, pp217-231.

Nahapiet, H., Nahapiet, J. (1985a). *The Management of Construction Projects: Case Studies from the USA and UK*, Chartered Institute of Building, Englemere, Berkshire.

Nahapiet, J. (1988). 'The rhetoric and reality of an accounting change: A study of resource allocation', *Accounting Organizations and Society,* **13** (4), pp333-358.

National Economic Development Office (1970). *Large Industrial Sites,* Report of the Working Party on Large Industrial Construction Sites, HMSO, London.

National Economic Development Office (1974). *Before You Build: What the client needs to know about the construction industry*, Economic Development Committee for Building and Civil Engineering, HMSO, London.

National Economic Development Office (1976). *The Professions in the Construction Industries*, Economic Development Committee for Building and Civil Engineering, HMSO, London.

National Economic Development Office (1976a). *Engineering Construction Performance*, Report of the Comparative Construction Performance Working Party, NEDO, London.

National Economic Development Office (1978). *Construction for Industrial Recovery*, Economic Development Committee for Building and Civil Engineering, HMSO, London.

National Economic Development Office (1983). *Faster Building for Industry*, Economic Development Committee for Building, HMSO, London.

National Economic Development Office (1985). *Thinking About Building: A successful business customer's guide to using the construction industry,* Economic Development Committee for Building, HMSO, London.

National Joint Consultative Council (1973). *Client's Guide: The Role of the Client in the Design of Buildings*, RIBA Publications Ltd., London.

Newcombe, R., Langford, D., Fellows, R. (1990). *Construction Management 1. Organisation systems*, Mitchell (in association with CIOB). London.

Newcombe, R., Langford, D., Fellows, R. (1990a). *Construction Management 2. Management systems*, Mitchell (in association with CIOB). London.

Newman, R., Jenks, M., Dawson, S., Bacon, V. (1981). *Brief Formulation and the Design of Buildings*, Department of Architecture, Oxford Polytechnic, Oxford.

Nutt, P.C. (1984). 'Types of Organizational Decision Processes', *Administrative Science Quarterly,* **29**, pp414-450.

Nyman, S., Silberston, A. (1978). 'The ownership and control of industry', *Oxford Economic Papers,* **30** (1), March, pp74-101.

O'Neill, J.J. (1989). *Management of Industrial Construction Projects,* Heinemann Newnes, Oxford.

O'Reilly, J.J.N. (1987). *Better Briefing Means Better Buildings*, Building Research Establishment Report, BRE, Garston, Watford.

Pettigrew, A. (1973). *The Politics of Organizational Decision Making*, Tavistock Publications, London.

Pike, R.H. (1983). 'A review of recent trends in formal capital budgeting processes', *Accounting and Business Research,* **51** Summer, pp201-208.

Pinches, G.E. (1982). 'Myopia, capital budgeting and decision making', *Financial Management,* **11** (3), Autumn, pp6-19.

Porter, M.E. (1980). *Competitive Strategy*, Free Press, New York.

Porter, M.E. (1985). *Competitive Advantage*, Free Press, New York.

Porter, M.E. (1990). *The Competitive Advantage of Nations*, Free Press, New York.

Prahalad, C.K. (1975). *The Strategic Process in a Multinational Corporation*, unpublished doctoral dissertation, Harvard University, Boston.

Prais, S.J. (1976). *The Evolution of Giant Firms in Britain: A Study of the Growth of Concentration in Manufacturing Industry in Britain 1909-70,* Cambridge University Press, Cambridge.

Quinn, J.B. (1980). *Strategies for Change: Logical Incrementalism,* Irwin, Homewood, Ill.

Reference Publishers International Ltd. (1988). *International Directory of Company Histories* (5 volumes). St James Press, Chicago.

Royal Institute of British Architects (1973). *Plan of work for design team operation,* RIBA Publications, London.

Royal Institute of British Architects (1992). *Strategic Study of the Profession. Phase 1: Strategic Overview,* RIBA, London.

Royal Institution of Chartered Surveyors (1981). *Taking New Premises: A Guide to Industrialists*, Surveyors Publications, London.

Royal Institution of Chartered Surveyors (1982). *Report on building procurement* (Unpublished - confidential to members). RICS, London.

Royal Institution of Chartered Surveyors (1991). *QS 2000: The Future Role of the Chartered Quantity Surveyor*, RICS, London.

Rumelt, R.P. (1974). *Strategy, Structure and Economic Performance,* Harvard University Press, Cambridge, Mass.

Salisbury, F. (1990). *The Architect's Handbook for Client Briefing,* Butterworth Architecture, London.

Scapens, R.W., Sale, J.T. (1981). 'Performance measurement and formal capital expenditure controls in divisionalised companies', *Journal of Business Finance and Accounting*, Autumn 1981, pp389-419.

Schall, L.D., Sundem, G.L., Geijsbeek, W.R. (1978). 'Survey and Analysis of capital budgeting methods', *Journal of Finance*, March, pp281-287.

Schatzman, L., Strauss, A. (1973). *Field Research*, Prentice Hall, Englewood Cliffs, N.J.

Schilit, W.K. (1984). 'Sustaining your political position in strategy making', *Strategic Planning Management*, May, pp1-6.

Schilit, W.K. (1990). 'A Comparative Analysis of Strategic Decisions', *Journal of Management Studies*, **27** (5), pp435-461.

Schilit, W.K., Locke, E.A. (1982). 'A study of upward influence in organizations', *Administrative Science Quarterly*, **27**, pp304-316.

Schilit, W.K., Paine, F.T. (1987). 'An examination of the influence of middle level managers in formulating and implementing strategic decisions', *Journal of Management Studies*, **24**, pp271-293.

Schwartz, J. (1973). *The Decision to Innovate*, Unpublished DBA thesis, Harvard Business School, Boston.

Scott, B.R. (1971). *Stages of Corporate Development. Part 1*, Unpublished paper, Harvard Business School, Boston.

Scott, J.D. (1963). *Vickers: A History*, Weidenfeld and Nicolson, London.

Shrivastava, P., Grant, J.H. (1985). 'Empirically derived models of strategic decision-making processes', *Strategic Management Journal*, **6**, pp97-113.

Sihler, W.W. (1964). *The Capital Investment Analysis and Decision Process at the Plant Level of a Large, Diversified Corporation*, Unpublished doctoral dissertation, Graduate School of Business Administration, Harvard University, Boston.

Simon, H.A. (1945). *Administrative Behavior: A Study of Decision Making Processes in Administrative Organisation*, Macmillan, New York.

Simon, H.A. (1957). *Models of Man*, Wiley, New York.

Simon, H.A. (1960). *The New Science of Management Decision*, Harper and Row, New York.

Simon, H.A. (1976). *Administrative Behavior: A Study of Decision Making Processes in Administrative Organisation*, 3rd edition, Macmillan, New York.

Skitmore, R.M., Marsden, D.E. (1988). 'Which procurement system? Towards a universal procurement selection technique', *Construction Management and Economics,* **6** Spring, pp71-89.

Slough Estates (1976). *Industrial Investment: A Case Study in Factory Building*, Slough Estates Ltd., Slough.

Slough Estates (1979). *Industrial Investment: A Case Study in Factory Building,* 2nd edn, Slough Estates Ltd., Slough.

Smith, G., Morris, T. (1992). 'Exploiting Shifting Boundaries', in RIBA, *Strategic Study of the Profession. Phase 1: Strategic Overview,* pp61-78., RIBA, London.

Stocks, R.K., Male, S.P. (1983). 'An investigation into the client's perceptions of contractual forms and procedures', *SERC Final Report No. GR/C/2966.9*, Science and Engineering Research Council, Swindon.

Stone, P.A. (1983). *Building Economy,* Pergamon, London.

Stopford, J.M., Baden-Fuller, C. (1990). 'Corporate rejuvenation', *Journal of Management Studies,* **27** (4), pp399-415.

Taylor, F.W. (1947). *Scientific Management,* Harper, London and New York.

The Guardian, (1992). Injection into R&D arm vital to drugs industry, 8 August 1992, p32.

The Times (1988). *The Times 1000: various,* Times Books Limited, London.

Thompson, J.D., Tuden, A. (1956). 'Strategies, structures and processes of organizational decisions', in *Comparative Studies in Administration,* Thompson, J.D., pp195-216, University of Pittsburgh Press, Pittsburgh.

Turner, D.F. (1983). *Building Contracts: A practical guide,* 4th edn, George Godwin, London.

Vickers Plc (1981). *Vickers Annual Report and Accounts 1981,* Vickers Plc, London.

Walker, A. (1984). *Project Management in Construction*, Granada, London.

Walker, A. (1989). *Project Management in Construction,* 2nd edn, BSP Professional Books, Oxford.

Walker, A., Hughes, W.P. (1984). 'Private industrial project management: a systems-based case study', *Construction Management and Economics,* **2**, pp93-109.

Walker, R. (1985). 'An Introduction to Applied Qualitative Research', in *Applied Qualitative Research,* Walker, R. (ed), pp3-26., Gower, Aldershot.

Walker, R. (ed) (1985a). *Applied Qualitative Research,* Gower, Aldershot.

Warwick, D.P. (1975). *A Theory of Public Bureaucracy: Politics, Personality and Organization in the State Department,* Harvard University Press, Cambridge, Mass.

Webb, E., Cambell, D.T., Schwartz, R.D., Secherst, L. (1966). *Unobtrusive Measures: Nonreactive Research in the Social Sciences,* Rand McNally, Chicago.

Williams, B.R., Scott, W.P. (1965). *Investment Proposals and Decisions,* Allen and Unwin, London.

Williamson, O.E. (1964). *The Economics of Discretionary Behavior: Managerial Objectives in a Theory of the Firm,* Prentice Hall, Englewood Cliffs, N.J.

Williamson, O.E. (1971). 'Managerial discretion, organization form and the multi-division hypothesis', in *The Corporate Economy,* Marris, R., Wood, A. (eds), pp343-386., Macmillan, London.

Wilson, A. (Chmn) (1969). *Report of the Committee of Enquiry into Delays in Commissioning CEGB Power Stations* (The Wilson Report), Cmnd 3960, HMSO, London.

Woodward, J. (1965). *Industrial Organisation: Theory and Practice,* Oxford University Press, London.

Wrigley, L. (1970). *Divisional Autonomy and Diversification*, Unpublished doctoral dissertation, Harvard Business School, Boston.

Yin, R.K. (1984). *Case Study Research: Design and Methods,* Applied social research methods series: Vol 5., Sage publications, Beverly Hills, California

Yin, R.K., Bateman, P.G., Moore, G.B. (1983). *Case Studies and Organizational Innovation: Strengthening the Connection,* Cosmos Corporation, Washington D.C.

Zelditch, M. (Jr.) (1962). 'Some methodological problems of field studies', *American Journal of Sociology,* **67**, pp566-576.

APPENDICES

APPENDIX A A.1: LETTER TO POTENTIAL CASE STUDY HOSTS

17 January 1990
JNC/DRC

Dear

I have heard with interest of your recent involvement in __________ (project) ___.

I am undertaking research for a PhD degree about how large manufacturing firms obtain new factories from the construction industry. My study takes as its starting point the firm's need for productive capacity, and seeks to examine how this eventually becomes a completed building. Few studies of the building procurement process focus on the client's point of view. This does so in the belief that the firm's role as construction client is crucially important in ensuring that the right building is procured.

The work is being undertaken at Thames Polytechnic on a part-time post-graduate basis. I have enclosed a letter from my academic supervisor at Thames, Dr John Raftery, and my CV for information.

I propose to make a small number of case studies of recently completed factory investment projects. By focusing on the manufacturing firm's role my objects are practical: first, better to understand how a client's role evolves and is managed; second, to help clients and professionals to do their job more efficiently.

The attached briefing note expands a little on the research and outlines the requirements and benefits for firms who participate as case study hosts. Perhaps I may contact you in a few days time to discuss whether it would be possible to base a case study on __________ (project) ________, and indeed, whether there are other projects with which you have been involved which may also be suitable.

Yours sincerely

J N Connaughton

APPENDIX A A.2: BRIEFING NOTE FOR CASE STUDY HOSTS

MAKING AND IMPLEMENTING INDUSTRIAL BUILDING INVESTMENT DECISIONS

Focus and perspective

This study is about how the large manufacturing firm seeking a new factory ensures that it gets the building it needs. Its primary focus is on the manufacturing firm and the perspective taken is that of the firm as construction industry client. In this respect it departs significantly from many previous studies in building management and procurement which tend to concentrate on the points of view of the property and construction industries.

Outline problem statement

It sets out to address two specific problems for the firm's management. The first concerns how the firm manages the contribution of the construction industry to the process by which the firm defines its building requirements. The second is that prior to the completion of construction, the firm's requirements may change such that the building originally conceived is no longer suitable. A key question for the firm's management then, given these problems, is how to ensure the firm gets a suitable building.

Approach

Recent work in the business administration of social science describes corporate capital investment as a process of resource allocation occurring across levels of the corporate hierarchy and over long periods of time[1]. This study considers the manufacturing firm's involvement in the procurement of a new factory building as part of the process of resource allocation rather than as an end result of it. A resource allocation model [2] is used to examine how the firm goes about obtaining a new factory building and the study raises important human and organisational questions which have been largely ignored in construction studies up to now. The view is taken that a management approach, grounded in a well documented model will allow for a serious exploration of the key issues involved.

Method and outcome

The research involves a detailed study of the process of factory investment decision making and implementation within the large firm. Two retrospective case studies of recently completed factory building projects are planned and firms with recent investment experience are therefore invited to be case study hosts.

By examining the client's role on construction projects it is hoped that two practical objectives will be achieved. First, building professionals may learn more about how to satisfy their corporate client's objectives. Second, the client's role may be more clearly understood and, as a consequence, performed more effectively.

A.2 (cont'd)

Implications for case study hosts

The willing participation of case study hosts is essential to a successful study. Host firms will be asked to provide access to individuals and records. In return there will be a number of benefits for participating firms. The roles, requirements and benefits are set out below.

1 The principal questions to be addressed are:

a) Why and how did the need for a new factory arise?
b) How was the scope of the project defined?
c) Was the scope of the project changed during the decision or implementation process? What caused this change?
d) What was the role of those personnel with responsibility as construction client during the decision and implementation of the investment project?
e) How did the firm ensure that it got a suitable building?

2 The answers to these questions will be sought from:

a) Interviews with key participants in the investment decision and implementation process.
b) Relevant documentary sources such as plans, forecasts, progress reports, meeting minutes, etc.
c) Interviews with external consultants and contractors if appropriate.

3 The implications for the host firm are:

a) Access to (perhaps confidential) information is required, but confidentiality and discretion are assured. The researcher is a professional quantity surveyor undertaking private research and not directly involved in manufacturing industry.
b) Permission to interview key personnel within the firm is essential. Every effort will be made to minimise the demands on the firm's time. As an indication, some 6 to 8 interviews, each of approximately 1 hour's duration, are anticipated.
c) A copy of the full case study will be provided to each participating firm on completion of the study, together with a comparison with the other case study and a summary of the project findings. The inter-case comparison and analysis of how firms set out to ensure that suitable buildings are obtained is expected to shed new light on the process of investment decision making and implementation in the large manufacturing firm.

References

1. For a brief summary, see Marsh *et al* (1988) *Managing Strategic Investment Decisions*, London Business School.

2. The model proposed is from Bower (1970) *Managing the Resource Allocation Process*, Harvard University Press, Boston.

APPENDIX B B.1:INFORMANTS INTERVIEWED

Interview requested			Interview granted
Glaxo: CAOS/K2A			
Bolton	S	CMC/customer representative	Yes
Cannon	C	GGR/development planner	Yes
Chandler	C	Glaxo Pharmaceuticals/managing director	No
Frosini	K	Glaxo Operations/logistics	Not available
Hatfield	S	Glaxo Operations/project manager	Yes
Laxton	J	Glaxo Operations/project manager	Yes
Nathan	M	Glaxo Operations/resource planner	Yes
Parker	J	GGR/chairman of CAOS Project Team	No
Spackman	T	Glaxo Pharmaceuticals/tech transfer	Yes
Vickers: Dreadnought			
Blackmore	G	VDS/chief executive	No
Carlton	P	VDS/production engineer	Yes
Davies	B	VDS/works engineer	Not available
Hammond	J	VDS/financial controller	Yes
Preston	J	VDS/deputy managing director	Yes
Willis	S	VDS/commercial director	Yes
Nicholson	T	Consultant project manager	Yes

APPENDIX B B.2 INTERVIEW OUTLINES

B.2.1 INTERVIEW OUTLINES: ALL INFORMANTS

1 Introduction

1.1 What was your role on __(project)__? What was the role of your division/department/company at that time?

1.2 What, from your perspective, were the project priorities?

2 Background

2.1 How did the need for the __(project)__ facility arise?

2.2 When was this?

2.3 In what terms was the original need for a new facility expressed? (Prompt on: shortfall in capacity; need to reduce costs; need to incorporate new technology; need to increase quality; need to obtain return on investment, etc)

3 Definition

3.1 Who was responsible for identifying this need? Would that person(s) normally be responsible?

3.2 Were top management involved in this at all? In what way?

3.3 Can you describe the process by which __(the firm)__ defined its building requirements, in particular in terms of:

1 The personnel involved?
2 The information required?
3 The extent of detail involved?
4 The time taken?
5 The management of this process?

3.4 What were the top management requirements in respect of this project? How were these communicated to those involved in facility definition?

3.5 When was the construction industry first involved in this process? What was their role and how did it change between their first involvement and submission of the CAR?

3.6 Who was responsible for managing the construction involvement in the project during this process? How was this achieved?

4 Impetus

4.1 Who was responsible for compiling the CAR? Who were the main contributors and what were their contributions?

4 Impetus (cont'd)

4.2 Who was the person (or group) most instrumental in moving the project forward prior to approval of the CAR?

4.3 How was this achieved?

4.4 What were the formal approval procedures? Were these followed?

4.5 How important was the informal liaison between the various participants?

4.6 Were top management involved in moving the project forward? If so, in what way?

4.7 Were there any requirements for expenditure on the project prior to top management approval of the CAR?

4.8 What effect did this have on:

1 Those involved in facility definition?
2 Those involved in moving the project forward?

4.9 Was there any need for early approval of the CAR to secure early completion of the facility (or completion within certain cost constraints)?

4.10 What effect did this have on:

1 Those involved in facility definition?
2 Those involved in moving the project forward?

5 Changing definition prior to funding approval

5.1 As the definition of the facility progressed and the project was moved toward funding approval:

1 What main changes to facility definition were introduced?
2 Why and by whom?
3 How were these changes incorporated?

5.2 Did top management introduce any such changes? If so, how and why?

6 The role of top management

6.1 How would you describe the role of top management in the definition of the new facility required?

6.2 Did top management attempt to influence the definition of the project in any way prior to submission of the CAR, either:

1 By intervening directly in the process?
2 By intervening less directly?
(Prompt on appointing key personnel, changing the organisational structure, setting financial targets/limits, etc)

6 The role of top management (cont'd)

6.3 What criteria were used in the evaluation of the CAR by top management?

6.4 Was the project referred for further detail/information? What normally happens?

7 Building and changing new facilities

7.1 What happened to facility definition between submitting the CAR and its approval by top management?

7.2 What changes were made to facility definition following funding approval by top management?

7.3 Were these changes anticipated? By whom? What provision was made for incorporating these changes during construction?

7.4 Who initiated these changes? How were these changes incorporated?

7.5 To what extent did these changes require approval by top management?

7.6 What were the procurement and project management arrangements for the new facility?

B.2.2 SUPPLEMENTARY QUESTIONS: GLAXO CAOS/K2A INFORMANTS

1 Bolton (CMC Customer Representative)

1.1 What input did you have to facility definition?

1.2 To what extent were you involved in briefing:

1 the Glaxo project manager;
2 the construction consultants/contractors

about what the CMC required of the new facility? Was there a formal written brief for this?

1.3 What was your contribution to the CAR?

1.4 How would you describe your relationship with the Strategic Planning Unit? Who was responsible for translating forecasts of market demand into estimates of capacity required, and eventually into estimates of facility size? How was this done?

1.5 What was your involvement (following the submission of the CAR) in helping to progress the project toward funding?

1.6 What was your involvement in:

1 The batch plant change?
2 The fallow area change?

1.7 How did your role and that of Kevin Frosini (logistics) overlap and/or interrelate?

1.8 How did your roles and responsibilities change as the project developed?

1.9 Did these change as a result of changes to either the corporate or the project organisational structure? If so, when and how?

1.10 Have there been any post-implementation evaluation studies on K2A? What were the findings?

1.11 As the CMC 'customer', were you satisfied with the outcome of the K2A project? (Prompt on date of availability, capacity, quality of building, etc)

B.2.2 (cont'd)

2 Cannon (GGR Development Planner)

2.1 Can you describe the process by which CAOS arose from within the research company as a product which was to be developed into full production? Who was sponsoring/promoting this product as one deserving of development effort? Why?

2.2 At what stage was it decided to develop CAOS into full production? Who made that decision, and how?

2.3 Are choices of markets and choices of particular products to be sold in them made by different people and/or at different hierarchical levels within Glaxo? How are these choices made?

2.4 Was the development process for CAOS different than for other, similar products? (Prompt on time taken, cost, extent of technical problems encountered, extent of market uncertainties, etc.)

2.5 Can you outline the process of registration of this product with licensing authorities in major markets?

2.6 Who provided market forecasts and estimates of registration dates for major markets? How were these activities co-ordinated/managed?

2.7 Who made the decision to locate CAOS production at Barnard Castle? How and when was that decision made?

2.8 Why and how was the Technical Working Party established? What was your role in this?

2.9 What was your involvement in:

1 The batch plant change?
2 The fallow area change?

2.10 How did your roles and responsibilities change as the project developed?

2.11 Did these change as a result of changes to either the corporate or the project organisational structure? If so, when and how?

2.12 Can your describe the validation process for CAOS/K2A? Was this complicated by the changes to the formulation/changes to the process plant?

B.2.2 (cont'd)

3 Laxton (Project Manager)

3.1 What input did you have to facility definition?

3.2 To what extent were you involved in preparing the customer brief with Steve Bolton?

3.3 Who was involved in briefing the construction consultants and contractors? How was this done?

3.4 Did you contribute to the CAR prepared by Stewart Hatfield? In what way?

3.5 Who determined the size of the new facility? How was this done?

3.6 Who determined the project management arrangements for the K2A project? Were these any different than normally used? In what way?

3.7 Who decided on the form of procurement for the K2A building works? On what basis?

3.8 What was your involvement in:

1 The batch plant change?
2 The fallow area change?

3.9 How was the fallow area change incorporated, in particular in terms of the building contract?

3.10 What were the origins of the delay to the K2A construction programme? How was the delay resolved with the contractor? What overall effect did this delay have?

3.11 How did your roles and responsibilities change as the project developed?

3.12 Did these change as a result of changes to either the corporate or the project organisational structure? If so, when and how?

3.13 Have there been any post-implementation evaluation studies on K2A? What were the findings?

3.14 As project manager, were you satisfied with the outcome of the K2A building project? (Prompt of date of availability, cost, quality of building, performance of participants, etc)

4 Nathan (Resource Planner)

4.1 Are choices of markets and choices of particular products to be sold in them made by different people and/or at different hierarchical levels within Glaxo? How are these choices made?

4.2 What competitor products existed around the time it was decided to bring CAOS to market (mid-to-late 1986)? What were Glaxo's main competitors planning to do with their products?

4.3 What input did you have to facility definition?

4.4 How would you describe your relationship with Steve Bolton and the facilities project management team whose responsibilities included the definition of the scope of the new facility required?

4.5 What triggers market forecasts? Can you describe the process by which forecasts of market demand are translated into estimates of capacity required and eventually into estimates of facility size?

4.6 Who provided market forecasts and estimates of registration dates for major markets? How were these activities co-ordinated/managed?

4.7 Who made the decision to locate CAOS production at Barnard Castle? How and when was that decision made?

4.8 What was your contribution to the CAR written by Stewart Hatfield?

4.9 What was your contribution in helping to progress the CAR through the approvals system? How important was informal contact and liaison with personnel in the authorisation chain throughout this process?

4.10 For K2A, what where the criteria determining the overall feasibility or desirability of the investment from a Group point of view?

4.11 What was your involvement in:

1 The batch plant change?
2 The fallow area change?

4.12 What was the 'mechanism' for implementing change when market forecasts were revised?

4.13 How did your roles and responsibilities change as the project developed?

4.14 Did these change as a result of changes to either the corporate or the project organisational structure? If so, when and how?

5 Spackman (Technologist)

5.1 What input did you have to facility definition?

5.2 Was the development process for CAOS different than for other, similar products? (Prompt on time taken, cost, extent of technical problems encountered, extent of market uncertainties, etc.)

5.3 What were the main technological problems in 'scaling-up' the secondary production process from the manufacture of research batches to the full production level?

5.4 In translating estimates of capacity into estimates of facility size, how important were questions of the size of the batch plant required. At what point did increasing market forecasts require increases in batch plant size for the equipment used on K2A?

5.5 Why and how was the Technical Working Party established? What was your role in this?

5.6 Can you describe the main changes in product packaging which occurred during the period when the facility was being defined? What impact did these have on project programme and cost?

5.7 What was your involvement in:

1 The batch plant change?
2 The fallow area change?

5.8 Why do you think the technical director was so concerned about the single tower 1000kg batch plant to request a change to two towers?

5.9 How did your roles and responsibilities change as the project developed?

5.10 Did these change as a result of changes to either the corporate or the project organisational structure? If so, when and how?

B.2.3 SUPPLEMENTARY QUESTIONS: VICKERS DREADNOUGHT INFORMANTS

1 Carlton (Production Engineer)

1.1 What was your input to facility definition?

1.2 What was your involvement on decisions as to the sizing of Dreadnought? How critical were likely variations in vehicle throughput to the sizing of the facility?

1.3 What were the production implications of accommodating a 'double order'?

1.4 How significant was the size and shape of the Scotswood Road site to the size and shape of the facility eventually built on it?

1.5 To what extent were you involved in briefing the construction consultants and/or contractors on Dreadnought? Was there a formal written brief for this?

1.6 What was your contribution to the CAR?

1.7 What were the key problems in the design of the heavy machine bases?

1.8 When was the final factory layout determined, and by whom? How were decisions as to production flows and machinery layout integrated with the factory design/construction programme? Who managed that process?

1.9 Who decided on which of the production processes/activities at Elswick were to be retained and which were to be disposed of/contracted out? On what basis were these decisions made?

1.10 Who organised the machine move from Elswick? How was this done?

1.11 How did your roles and responsibilities change as the project developed?

1.12 Did these change as a result of changes to either the corporate or the project organisational structure?

1.13 From a production point of view, were you satisfied with the outcome of the Dreadnought project? (Prompt on date of availability, capacity, quality of building, etc)

B.2.3 (cont'd)

2 Hammond (Financial Controller)

2.1 Can you describe the background to Blackmore's appointment to VDS? Who appointed him as chief executive, and why?

2.2 Can you describe the extent of the business review of VDS undertaken by Blackmore following his appointment in December 1980?

2.3 What was the order position in VDS at that time? What was the likelihood of future major orders?

2.4 What do you think were the key considerations in the choice of investment in a new facility as opposed to the refurbishment of Elswick?

2.5 What was your input to facility definition?

2.6 What was your contribution to the CAR? Who identified the investment alternatives presented in the CAR?

2.7 How important were the high operating costs at Elswick in making a financial case for investment in a new facility?

2.8 For Dreadnought, what where the criteria determining the overall feasibility or desirability of the investment from a Group/Corporate point of view?

2.9 What was your involvement (following the submission of the CAR) in helping to progress the project toward funding?

2.10 How did your roles and responsibilities change as the project developed?

2.11 Did these change as a result of changes to either the corporate or the project organisational structure?

2.12 Were you satisfied with the outcome of the Dreadnought project? (Prompt on overall costs and cost control procedures)

B.2.3 (cont'd)

3 Preston (Deputy Managing Director - VDS Leeds)

Note Jim Preston was Operations Director at the Royal Ordnance factory in Leeds at the time of project Dreadnought. He subsequently was project director on Dreadnought II at Leeds in 1986/87. This interview was held to provide background material on operational issues and on the project management and control arrangements on project Dreadnought.

3.1 The Leeds factory is very similar to the original Dreadnought factory, yet both sites are different. Can you explain why both factories are so alike?

3.2 Is the same level of capacity/throughput available at Leeds as at Newcastle?

3.3 How was investment in a new facility justified at Leeds?

3.4 What were the main changes in the design of the Leeds factory compared to the factory at Newcastle? Why were these made?

3.5 What were the main changes in the construction procurement and management arrangements at Leeds compared to Newcastle, in particular with respect to:

1 Responsibilities for design?
2 Project management arrangements?
3 Cost control arrangements?
4 Cost reporting arrangements?

3.6 How important was a speedy completion of construction work at Leeds?

3.7 How much did the experience gained on the Newcastle project help in the management and organisation of the Leeds project from a Vickers point of view?

B.2.3 (cont'd)

4 Nicholson (Consultant Project Manager)

4.1 When did you first become involved in the Dreadnought project?

4.2 I understand that you had worked with Gerald Blackmore prior to this. Can you briefly outline the projects you worked on together?

4.3 What, initially, were the key project objectives as you perceived them?

4.4 What do you think were the key considerations in the choice of investment in a new facility as opposed to the refurbishment of Elswick?

4.5 Who determined the form of procurement of the Dreadnought construction works? On what basis?

4.6 Why was the design of the heavy machine bases so important? Who decided to make this the main contractor's responsibility? Why?

4.7 On what basis were the main contractors' tenders evaluated? What were the key criteria in the selection of the successful contractor?

4.8 How did the change to the lean-to offices arise? Who was responsible for this? How was the change incorporated to the definition of the project contained in the CAR which had just been submitted to the executive committee?

4.9 A number of items were manufactured by Vickers for incorporation into the construction works? Why was this? How was the Vickers' manufacturing programme integrated with the construction programme? Who managed this?

4.10 Who determined the construction management and cost control procedures adopted?

4.11 What were the origins of the contractors' potential claims which were resolved at the third claims meeting in December 1981? How were these resolved?

4.12 What action was taken (by you and/or Vickers) to prevent a recurrence of potential claims?

4.13 What was your involvement in the procurement of items by Vickers, in particular cranes and cladding?

4.14 As project manager, were you satisfied with the outcome of the Dreadnought building project? (Prompt of date of availability, cost, quality of building, performance of participants, etc)

APPENDIX C: SOME ASPECTS OF THE PHARMACEUTICALS INDUSTRY

Research and Development

The UK pharmaceuticals industry currently spends about 15% of turnover on R&D compared to an average of 2% for manufacturing as a whole[1]. Market leadership in the research-based pharmaceuticals industry is shared between a small number of companies. These capitalise on their success in the discovery and development of new and marketable compounds by selling the resultant products under patent protection for up to eight years in as many markets as possible. The key to success is therefore the discovery of new compounds with clear therapeutic benefits.

As well as being costly, the research and discovery of new chemical entities and their development into pharmaceutical compounds which can be licensed and marketed as new drugs takes a long time, typically between 10 and 12 years. Furthermore, only a small number of research compounds progress to the later stages of product development; current estimates indicate that for every 10,000 new pharmaceutical compounds identified only one is launched on the market[2].

Competitive advantage

Glaxo's competitive advantage is seen as combining carefully targetted research on a small number of therapeutic areas with the acceleration of product development. Mike Nathan, (Glaxo Operations Resource Planning Manager on the CAOS project) explained:

> "One of our key competitive advantages is to bring products to market very quickly; we do that by time compression in the development phase. Normally it can take ten years to bring a product to market; we do it in around seven. And we only have a very small number of products in full development, compared to the rest of the industry. Some of our competitors may have up to 50 products in full development, many of which are quite small and they creep along. We have fewer than that, and we put a lot of resource and effort behind them... We only place big bets."[3]

Licensing and registration

The research-based pharmaceuticals industry is subject to a level of regulation and control by public authorities which is not found in most other industries. Statutory controls on research and the development of new products, on the conduct of clinical trials, the procedures for licensing and registration and the conditions under which new medicines may be marketed exist in most countries.

Briefly, approval for the sale of new products depends on the availability of two documents. The International Registration Dossier (IRD) forms the basis of Product License Applications (PLAs) in all non-USA markets. The New Drug Application (NDA) is the formal application to the Food and Drug Administration (FDA) in the USA. Both documents contain data to support the registration of the drug as efficacious for the treatment of the condition for which it is registered and safe for administration to people. The 'clinical section' contains detailed information on the biological effects of the drug including such matters as rate of absorption, efficacy, tolerance/intolerance, side effects and so on. For new products, this data is generated from 'clinical trials' which involve the controlled administration of the drug to groups of volunteer patients. The 'chemical/pharmaceutical' section contains data on the drug itself and its method of manufacture including such matters as the chemical composition of the drug, the analytical methods used, the method and place of manufacture, the container in which it will be sold and closure system, the stability of the product in this container, and so on.

The gap in submitting PLAs/NDA and receiving approval to enable products to be launched is on average between one and two years, but tends to vary by country and by product. The timing of product launch and related production matters - such as stockpiling - are critically dependent on the registration programme. Prior to this, however, samples of the product are required by a number of regulatory authorities for analysis of the drug being registered.

Public scrutiny

Finally, there is a good deal of public interest in the activities of pharmaceutical companies, particularly concerning profitability from the sale of health care products, the conduct of research and marketing. Pharmaceutical companies in turn seek to influence public policy regarding the development and marketing of new drugs. Regulations on patent protection have been the target of attention in recent years from manufacturers - like Glaxo[4] - who invest heavily in R&D and are keen to recover the costs of this through product sales under patent protection.

Footnotes

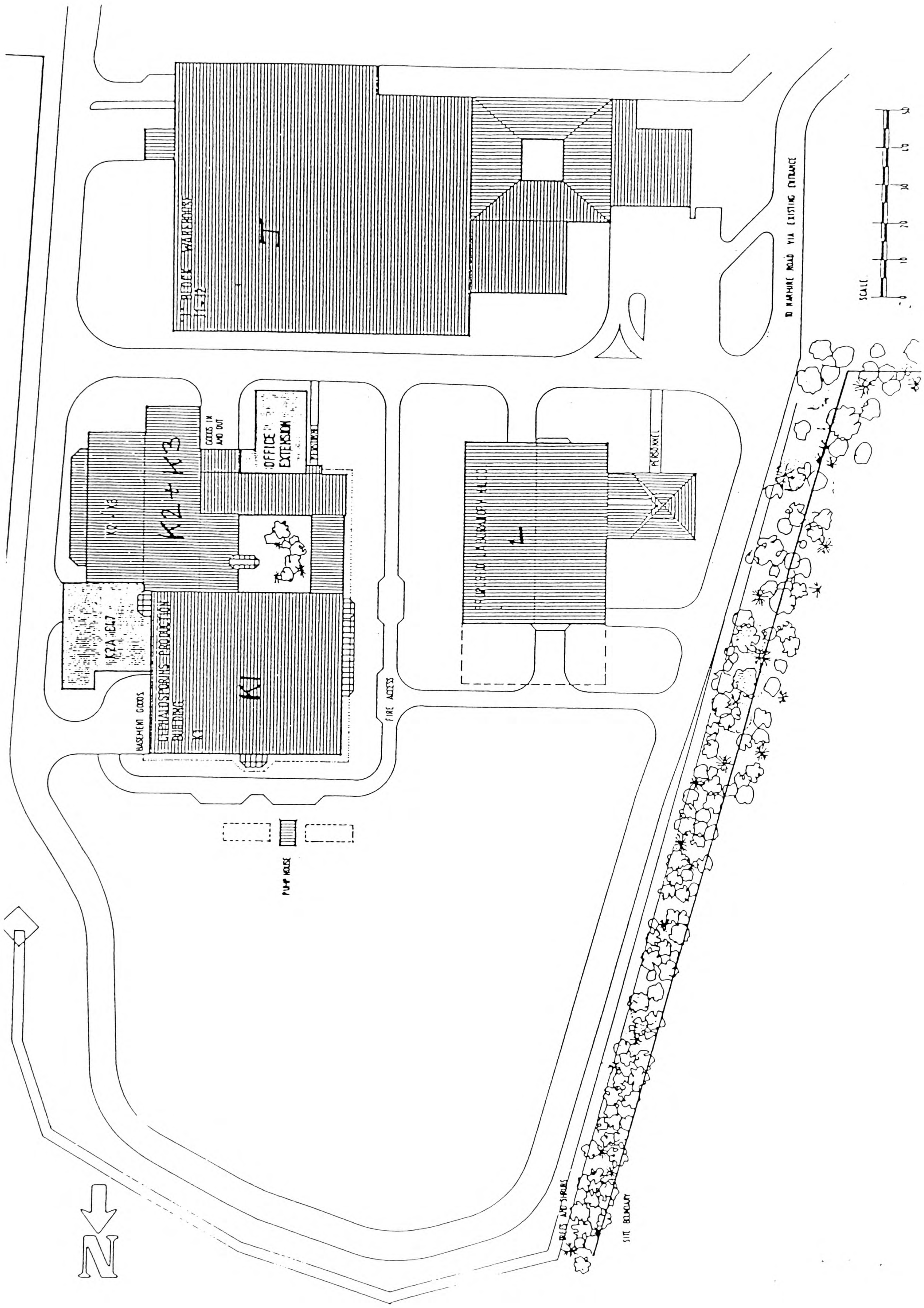
1 See Company Reporting (1992); Company Reporting's R&D Scoreboard ranked Glaxo second in the UK (to ICI) in terms of aggregate R&D expenditure in 1991.

2 *The Guardian*, 8.8.92, p32.

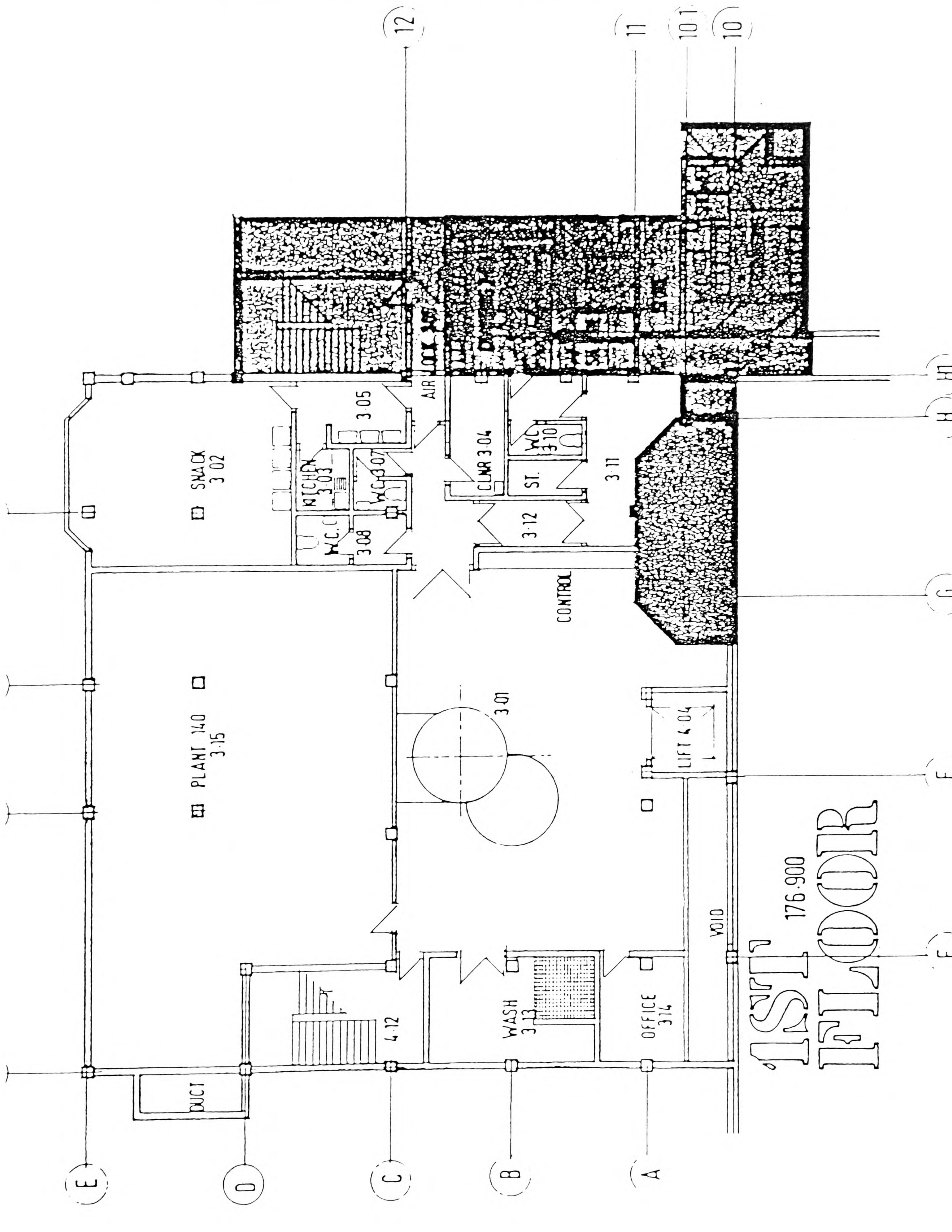
3 In discussion with the author, 1992.

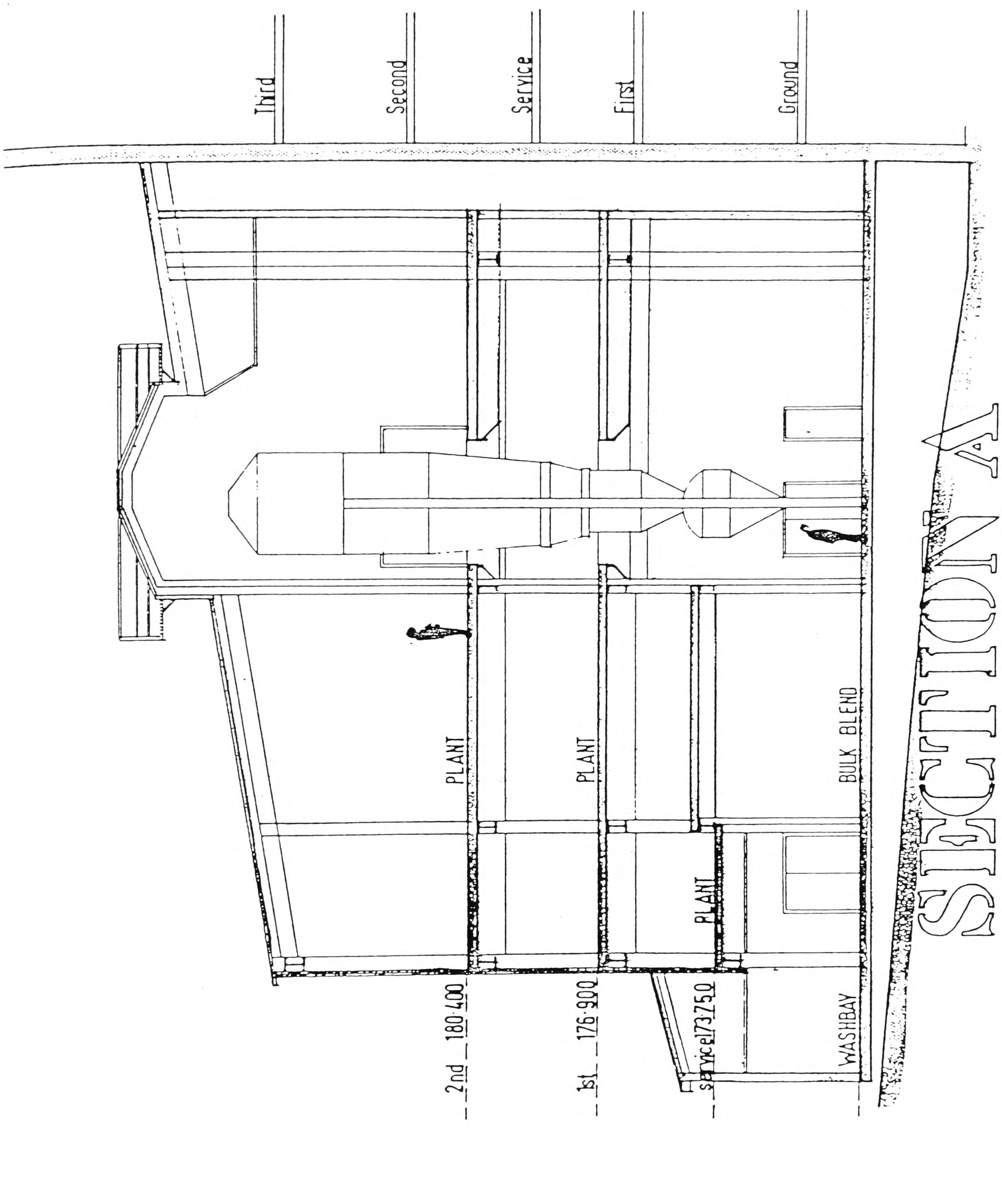
4 See Glaxo Holdings Plc (1990), in particular the Review and Directors Report, p10.

APPENDIX D D.1: K2A - SITE AND BUILDING LAYOUT



APPENDIX D D.1: K2A - SITE AND BUILDING LAYOUT (cont'd)




Third
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PLANT
BULK BLEND
PLANT
WASHBAY
2nd 180·400
1st 176·900
service173·750
SECTION A

Project Justification		Part 2 Commentary
Company: GLAXO PHARMACEUTICALS LIMITED		Date: 17.4.89
Project Name: CEFUROXIME AXETIL GRANULE FACILITY - BARNARD CASTLE		
Currency: STERLING	rounded to:	

3.4 Using available capacity in 'C' Block

This option is not recommended for the following reasons:-

a) The 200 kilo granulator currently situated in "C" Block, combined with the K2 based capacity, will not provide the 350 tonnes annual capacity requested by GTC.

b) The provision of a permanent Cephalosporin facility in "C" Block does not meet the Cephalosporin segregation policy of Glaxo Pharmaceuticals.

c) The space in "C" Block has been provisionally earmarked for the temporary USA Cefuroxime Axetil granule production facility being progressed in parallel to this project.

4. PROPOSAL

It is proposed that:

4.1 The building to house the manufacturing of Cefuroxime Axetil granule for suspension will be an extension to the existing orals facility (K2) and situated along the east side of 'K' Block. (Appendix 2 refers).

4.2 The extension will accommodate all process stages involved in the manufacture of the granules and link directly to the existing orals facility. Packaging will take place on the existing 'K' Block packaging floor with direct access from the proposed extension. Existing changing rooms and service facilities will be utilised where possible.

4.3 The building will have a total floor area of 1732m^2 and provides for 4 production floors plus M/E plant space. (Appendices 3 to 6 show floor plans).

4.4 The building shell itself is a steel frame construction clad in protected profiled metal sheeting above a dwarf brick wall.

4.5 The internal structure of the building is designed around the main process plant, consisting of two 500kg batch size fluidised bed mixer-dryer-granulators.

Project Justification		Part 2 Commentary
Company: GLAXO PHARMACEUTICALS LIMITED		Date: 17.4.89
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Currency: STERLING	rounded to:	

4.6 The equipment and air-conditioning of the building is designed to provide for both GMP and the Occupational Hygiene requirements of the materials handled.

Features include:

a) All stages of manufacture are in enclosed plant and use gravity feed and vacuum conveying system to minimise exposure to the internal and external environment and staff.

b) All HVAC is controlled by the existing Building Management System to ensure maintenance of correct air flow patterns.

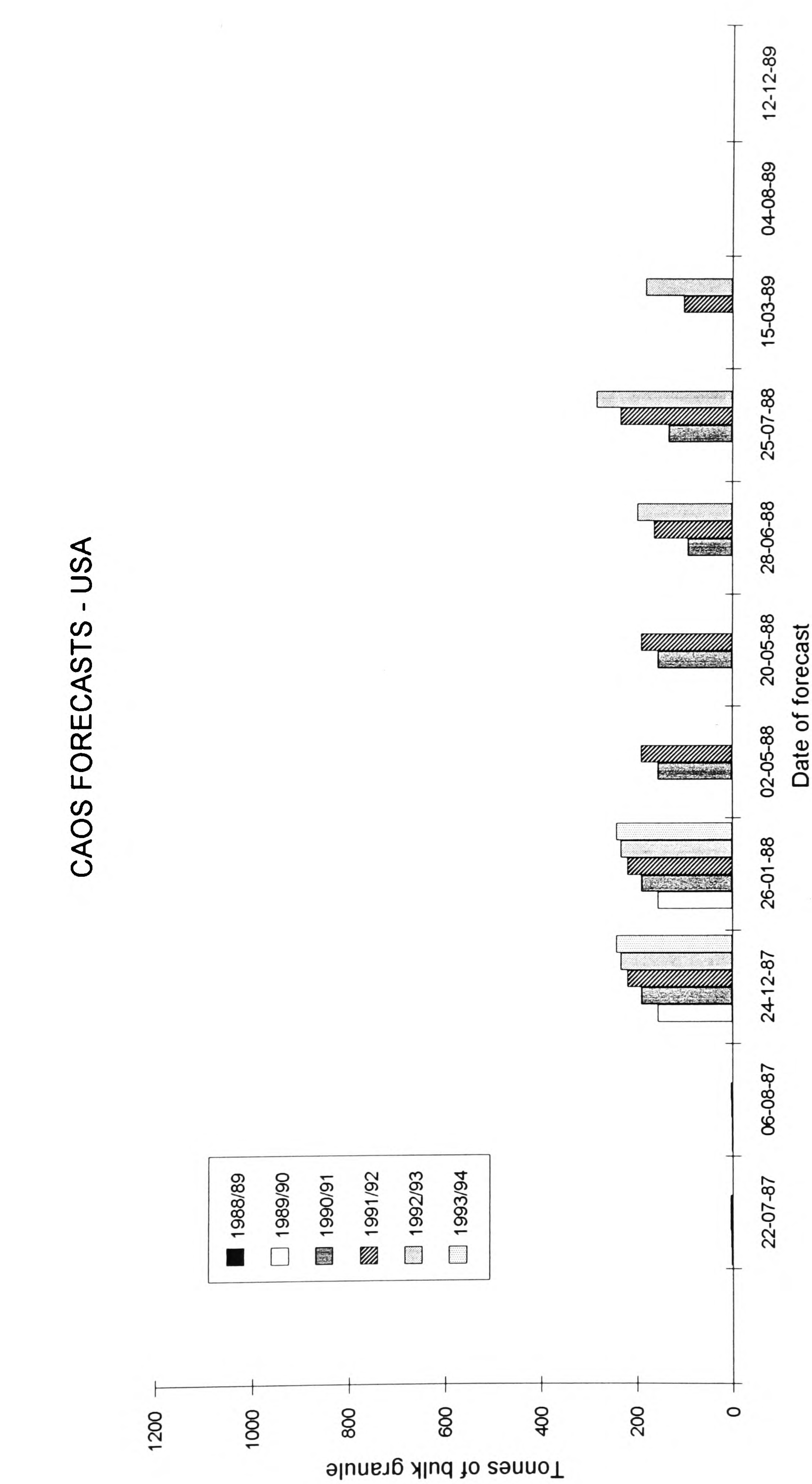
4.7 To provide a filling and packaging capacity to match the manufacturing capacity, it is proposed that an automated bottle filling and packaging line is purchased and installed in the 'K' Block packaging area. This new line, together with the existing granule packaging line, will provide the required capacity.

4.8 In order to provide adequate administrative and service facilities for the original filling and packaging department, together with the three new oral production units and to incorporate the service staff, from the support areas, into the newly created Manufacturing Centre of Excellence for Cephalosporins, it is proposed to extend the present open-plan office area.

The following appendices give more information on the proposal.

Appendix	Content
1	Site plan showing location of 'K' Block.
2	'K' Block showing extension.
3	Ground Floor plan.
4	Service Floor plan.
5	First Floor plan.
6	Second Floor plan.
7	Cross-section.
8	Process flow.
9	Prespend requirements.
10	Launch estimates.

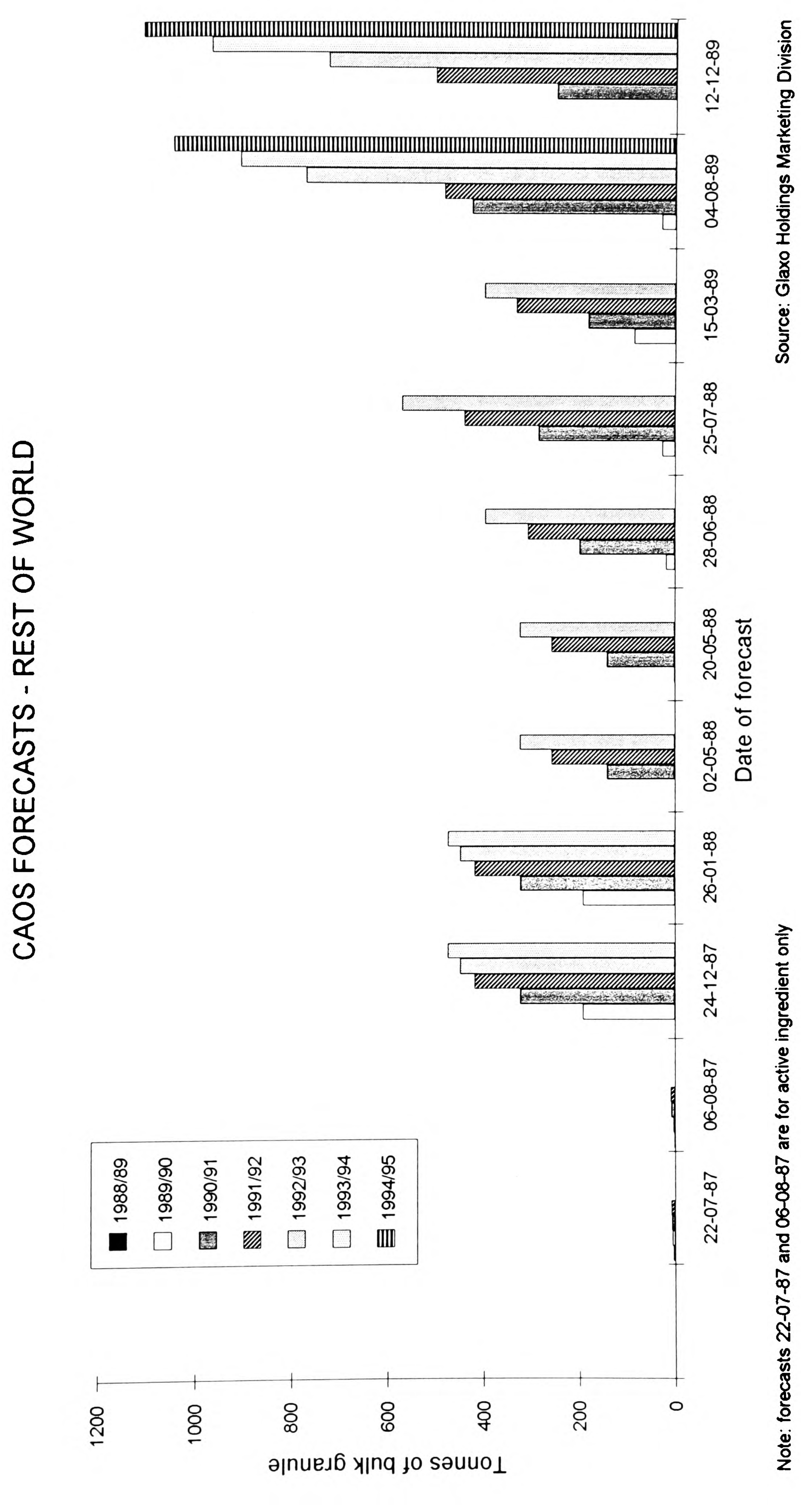
APPENDIX D D.3: CAOS market forecasts



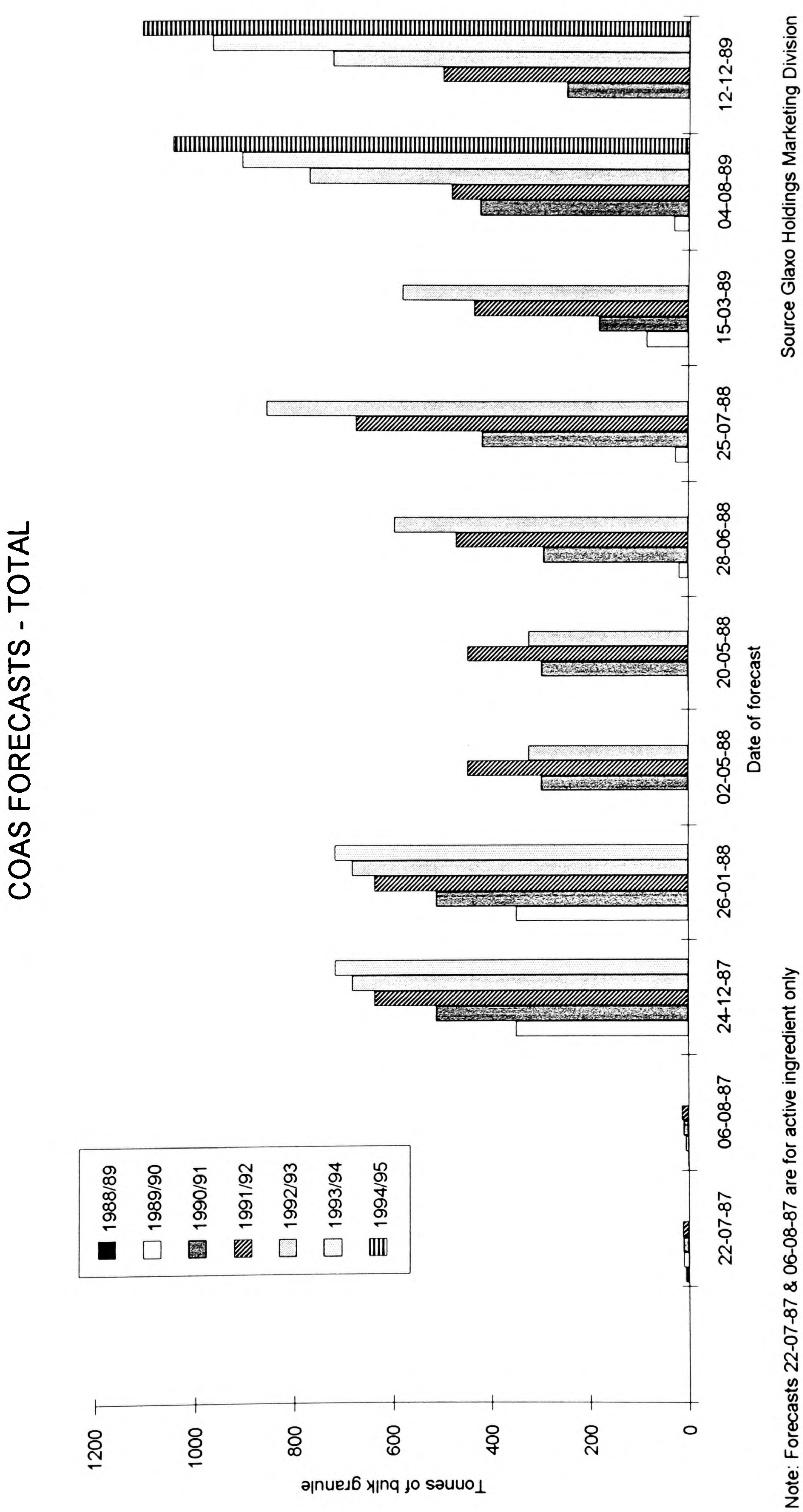
Note: Forecasts 22-07-87 and 06-08-87 are for active ingredient only

Source: Glaxo Holdings Marketing Division

APPENDIX D D.3: CAOS market forecasts (cont'd)



APPENDIX D D.3: CAOS market forecasts (cont'd)



APPENDIX D D.4: K2A TENDER SUM

The tender submitted for the 'two tower' scheme (excluding the fallow area) was :

Tender		£3,448,528

Post-tender reductions were made as follows:

Contingencies	£10,000	
Builders work in connection	£10,000	
Temporary screens (K2/K2A)	£20,000	
Drainage	£ 5,000	
Dayworks	£10,360	£ 55,360
Revised tender sum		£3,393,168

The revised tender sum may be broken down as follows:

PC sums	£1,927,600
Provisional sums	£ 524,100
Work to be sub-let on competitive tender	£ 315,000
Balance available for negotiation	£ 626,468
Total	£3,393,168

Reductions in the revised tender sum following negotiation amounted to:	£ 131,012
Agreed contract sum	£3,262,156

APPENDIX D D.5: K2A cost estimates

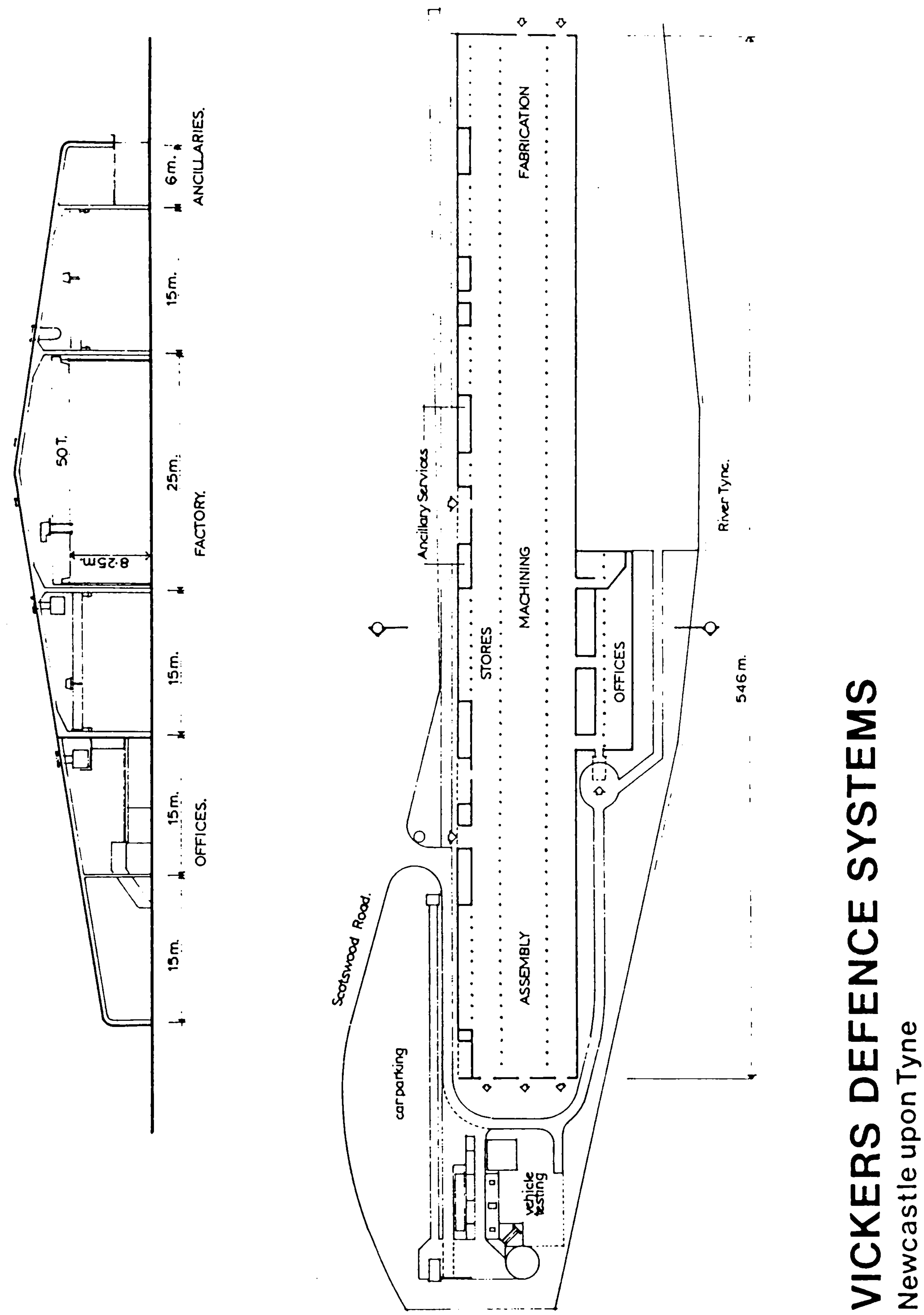
K2A CAPITAL COST ESTIMATES/COST REPORTS

£000S

Date of estimate/report

	15.1.88	29.3.88	14.6.88	13.1.89 Scheme A	Scheme B	16.3.89 (Scheme A)	17.4.89 Main DP	19.5.89 Fallow Area DP	7.7.89	5.10.89 Tender	7.12.89	6.6.90 Estimate of final A/C
K2A MAIN EXTENSION												
SUBSTRUCTURE						£245						
SUPERSTRUCTURE						£1,364						
Steelwork												
Cladding												
TOTAL BUILDING WORK	£1,250	£1,500	£1,650			£1,609	£2,320	£2,320			£2,150	£2,650
M&E SERVICES	£1,100	£1,100	£1,100				£1,390	£1,390			£1,350	£1,550
Mechanical						£1,172						
Electrical						£214						
TOTAL BUILDING COST	£2,350	£2,600	£2,750	£3,150	£5,150	£2,995	£3,710	£3,710	£3,865	£3,262	£3,500	£4,200
EQUIPMENT	£1,800	£1,800	£1,580	£1,830	£1,830	£2,080	£2,510	£2,510	£2,510	£2,510	£2,600	£2,800
PROFESSIONAL FEES	£350	£350	£460	£780	£1,130	£780	£452	£452	£452	£452	£460	£470
MANAGEMENT COSTS	£250	£250	£250	incl	incl	incl	£247	£247	£247	£247	£250	£270
COMMISSIONING AND VALIDATION	£250	£250	£200	£450	£450	£200	£220	£220	£200	£200	£200	£225
CONTINGENCY	not incl	not incl	£500	not incl	not incl	not incl	£180	£180	£180	£180	£180	incl
INFLATION	not incl	not incl	not incl	not incl	not incl	not incl	£480	£480	£480	£480	£450	incl
TOTAL PROJECT COST	£5,000	£5,250	£5,740	£6,210	£8,560	£6,055	£7,799	£7,799	£7,934	£7,331	£7,640	£7,965
FALLOW AREA EXTENSION												
MODIFICATIONS TO K2A								£395	incl	incl	incl	incl
FALLOW AREA												
Substructure								£80	incl	incl		
Superstructure								£240	£580	£580	£650	£665
M&E Services								£650	£255	£255	£260	£260
Fees etc								incl	£275	£275	£280	£280
Contingency								incl	£120	£120	£90	£90
TOTAL FOR FALLOW AREA								£1,365	£1,230	£1,230	£1,280	£1,295
REVISED TOTAL PROJECT COST								£9,164	£9,164	£8,561	£8,920	£9,260

APPENDIX E E.1: DREADNOUGHT - SITE AND BUILDING LAYOUT



APPENDIX E E.2: DREADNOUGHT - CAR extracts

Project Dreadnought

It is helpful to review this proposal against the background performance in the Defence sector over the past decade.

The key figures are shown below, all indexed to 1981 values. The actual results - unindexed - are included as Appendix A together with the annual multipliers. It should be noted that the profit figures are after interest and before taxation.

Year	Sales	Profit Pre Tax after Interest	Capital Employed at beginning of Year	Cash Flow	Net Capital Expenditure
	£000	£000	£000	£000	£000
1971	36,877	3,463	10,329	1,185	598
1972	19,482	2,735	11,846	(1,511)	598
1973	29,215	3,610	14,045	1,339	578
1974	19,657	2,682	21,060	2,904	441
1975	21,302	2,333	16,796	2,855	112
1976	29,628	2,899	13,761	2,579	719
1977	13,389	2,157	11,413	(1,992)	521
1978	24,917	2,605	14,024	4,245	741
1979	32,424	7,994	13,506	9,487	586
1980	33,588	6,491	5,337	9,811	203
1981 Plan	27,195	2,968	2,711	(2,685)	200
		39,937		28,217	5,297

To demonstrate that the future does not hold dissimilar opportunities there is profit potential on products which have already been defined.

1981-1982	Kenya	Vickers' MBT's balance of contract plus spares.
1982-1984	Nigeria	Vickers' MBT's, ARV's, Bridgelayers and spares.
1982-1983	MoD	ARV's as replacement for sales to Jordan.
1985	MCV 80	Turrets for 50% of the 2000 vehicles - say 1000 turrets.

If one now takes a totally downside view there is at least an opportunity for 1000 turrets on MCV 80 from 1985 onwards but the question is on our present cost structure and geographical layout - how do we get to 1985?

We cannot go on persuading people of our aspirations to be a credible source of hardware systems without an outward manifestation of our intentions and to do this we must make a major change in direction. I simply do not believe that we will even get to 1985 to take advantage of the business opportunities.

Cont./....

PROGRAMME OF CONSTRUCTION WORKS

The level of construction costs included in the Cost Plan are based on the following programme:-

1. Design brief frozen		February 1981
2. Design and preparation of invitation to tender and contract documentation	February	- May 1981
3. Select contractors		March 1981
4. Tender period	May	- July 1981
5. Tender approval		July 1981
6. Start on site		August 1981
7. Completion of contract		July 1982

The prices are based on current tendering trends, the market being very competitive with only marginal changes in the levels of tenders received over the past few months. It is anticipated that the tender would be based on the cost of construction at May/June 1981 levels.

PROJECT DREADNOUGHT

PROJECT MANAGEMENT SERVICES

1. Scope of Project

1.1 Size and Nature

The project consists of a simple shed of approximately 30,000m^2 for use as a medium/heavy engineering workshop with facilities for fabrication, light and heavy machinery, and finishing and assembly. Overhead cranage and basic mechanical and electrical services are to be provided within the shell. Office and welfare facilities of approximately 4,000m^2 are to be provided in free standing Portakabin units linked to the shed. External works will comprise ancillary buildings accommodating electrical substations, compressor houses, stores, etc., together with drainage, roadworks, car parking, fencing and landscaping. The estimated contract value at current prices is £6.6M.

1.2 Time Scale

1.	Design brief frozen	February 1981
2.	Design and preparation of invitation to tender and contract documentation	February/May 1981
3.	Select contractors	March 1981
4.	Tender period	May/July 1981
5.	Tender approval	July 1981
6.	Start on site	August 1981
7.	Completion of contract	June 1982

1.3 Construction Contract

Competitive Develop and Construct tenders will be sought from up to 4 contractors on the basis of outline designs and documents containing a Design Development Brief and Conditions of Tender. Selection of a tender will be on the basis of value for money with respect to total price and the suitability of contractors detailed proposals for the development of the design.

2. Project Management Services

2.1 Precontract

We will act to secure the most advantageous design and price for the project, and in particular:

2.1.1 We will take and analyse client's requirements and prepare outline designs.

2.1.2 We will carry out, as appropriate, necessary investigations into site conditions and will instruct specialists on your behalf. We will ascertain the requirements of the statutory authorities etc. likely to affect the design and/or its detailed development.

2.1.3 We will prepare a Design Development Brief and Conditions of Tender to form the basis of competitive tenders.

2.1.4 We will assist in the selection of contractors for inclusion in the tender list.

2.1.5 We will issue all necessary documents to competing tenderers, and during the tender period will issue to contractors any updating material required by you and will deal with contractors questions.

2.1.6 We will evaluate tenders and contractors detailed proposals and make recommendations to you on the placing of a contract.

2.2 Contract Stage

We will act on your behalf in carrying out the duties of the Employer within the terms of the contract. In particular we will:

2.2.1 Site Supervision and Quality Control

We will provide the necessary architectural, structural, mechanical and electrical engineering personnel to supervise the construction of the work in collaboration with a Clerk of Works to be appointed by you for the duration of the contract. We will provide the necessary services for dealing with unforeseen contingencies arising from underground conditions and existing structures as they may arise and will agree appropriate courses of action with the contractor and report to you on cost or other implications.

2.2.2 Progress and Liaison

We will undertake to convene and attend regular progress meetings with the contractor and will deal with them on a day to day basis over such matters as details of the phasing, access, temporary works and so on. We will report to you regularly on progress and on all matters affecting the continuation of your production in existing and new buildings.

2.2.3 Financial Control

We will undertake to agree with the contractor a payment plan and will value and certify regular monthly payments. We will be responsible for advising you of the financial implications of any proposed alteration to the design, or any other variation to the contract and will undertake the negotiation of the cost of any variation in accordance with the procedure laid down in the contract. We will, if appropriate, undertake to check and agree claims for increases in the cost of labour and materials in accordance with the NEDO formula for the fluctuating price parts of the contract.

2.2.4 Design

We will collaborate with you in the preparation of further design briefs required for the completion of the contract and will ensure that your requirements are properly incorporated in the production drawings prepared by the contractor.

2.2.5 Commissioning

We will supervise the testing and commissioning of the mechanical and electrical engineering services in the building and will test performance of installations against design criteria and will report to you and recommend acceptance on completion of commissioning.

2.2.6 Defects

In accordance with the terms of the contract we will undertake to prepare defects lists covering all fault arising from materials and workmanship not in accordance with the contract at the appropriate time in relation to the completion of each phase. We will check the making good of defects before authorising final release of retention to the contractor.

2.2.7 Final Account

We will undertake responsibility for preparing a final account between you and the contractor and authorising a final settlement.

3. Terms of Engagement

3.1 Our fees for the work are fixed and firm on the following basis:

Project Management Services Precontract are from 1 March 1981 to 31 July 1981.

Project Management Services at Contract Stage are for a construction programme from 1 August 1981 to 30 June 1982, and final discharge of defects liability and winding up of the final account by 1 August 1983.

Our engagement will in the first place cover precontract stage services only, with a further engagement for contract stage services to be made on the letting of a contract. In the event of the abandonment of the project during the course of either stage, the fee payable will be based on the proportion of the total work already carried out by the Project Managers. No fee will be payable in respect of the contract stage services if the project is abandoned during the pre contract stage.

3.2 All communication with the contractor concerning the building contract is to be through the project managers.

3.3 We authorise all payments to the contractor within the terms of the contract.

3.4 A competent Clerk of Works will be appointed by you to carry out the functions of quality control and progress monitoring throughout the period of construction.

APPENDIX E E.4: DREADNOUGHT - Extracts from Employer's Requirements

DREADNOUGHT: SCOPE OF WORKS

ELEMENT	DESIGN	DESIGN RESPONSIBILITY	TENDER BASIS
(1) FACTORY - MAIN BUILDING 55 metres (3 bays) wide by 546 metres (91 bays) long steel frames and metal sheeted and incorporating R.C. bases for a large number and variety of machines tools.	Foundations and machine bases: full design by Contractor.	Contractor	Contractor's price in tend
	Frame and Shell: Outline design by Employer's Agents (E.A.) detailed design by Contractor.	Contractor	Contractor's price in tend
	Mechanical and Electrical Services: full design by E.A.	Contractor	Contractor's price in tende
(2) FACTORY - OFFICE WING Attached wing 30 metre (2 bay) wide by 108 metre (18 bay) long including a first floor gallery 12 metres wide x 108 metres long.	Foundations: Full design by Contractor	Contractor	Contractor's price in tende
	Frame, Shell, Gallery structure, Main Toilets: outline design by Employer's Agents (E.A.) detailed design by Contractor.	Contractor	Contractor's price in tende
	Gables, office/factory partitions, subsidiary toilets, fitting out, mechanical and electrical services. Full design by Employer's Agents	Employer's Agents	Contractor's price in tend on Provisional Bill prepar by E.A.
(3) FACTORY - INTEGRAL ANCILLARIES Attached to North Bay of factory on one or two levels 3.1 Spray booths in fitting area. 3.2 Electroplating shop adjacent to fitting area. 3.3 Spray booth and shot blast in Fabrication Area.	Employer's Requirements to be determined	To be determined	Provisional Sum for desi construction and servicir included in tender.

ELEMENT	DESIGN	DESIGN RESPONSIBILITY	TENDER BASIS
3.4 4 No. Substations 3.5 2 No. Compressor Houses 3.6 1 No. Gas Meter and Water Intake Ho. 3.7 5 No. Toilet Blocks	Outline design by E.A. detailed design by Contractor	Contractor	Contractor's price in ter
(4) FACTORY - EXTERNAL ANCILLARIES Adjacent to South Bay of factory 4.1 Oil Storage Facilities 4.2 Paint Storage Facilities 4.3 Gas Storage Facilities	Employer's Requirements to be determined	To be determined	Provisional Sum for desig construction and servicin included in tender.
(5) TANK TESTING FACILITIES Buildings and structures located on south side of Factory/Office buildings 5.1 Suppression 'Shed' 5.2 Gun Control 5.3 Ramps to River	Employer's Requirements to be determined	To be determined	Provisional Sum for desig construction and servicin included in tender.
5.4 Winch Test 5.5 Water Test 5.6 Tilt Test 5.7 M.E.X.E. Bridge Test Blocks 5.8 Suspension Tests (bumps)	Outline design by E.A. detailed design by Contractor	Contractor	Contractor's price in ten

APPENDIX E E.4: DREADNOUGHT - Extracts from Employer's Requirements (cont'd)

ELEMENT	DESIGN	DESIGN RESPONSIBILITY	TENDER BASIS
(6) EXTERNAL WORKS			
6.1 Roads and surface finishes including fences, gates and gatehouse, landscaping site services and drainage.	Outline design by E.A. detailed design by Contractor	Contractor	Contractor's price in tend
6.2 External lighting.	Full design by E.A.	Contractor	Contractor's price in tend
(7) WORKS TO RIVER BANK Retaining structure necessar to support roads and external works by riverside at S.W. corner of building.	Employer's Requirements to be determined.	To be determined	Provisional sum for design and construction included in tender.

APPENDIX E E.5 DREADNOUGHT - INITIAL COST ESTIMATE AND TENDER SUM

The CAR indicated a total cash requirement for the project of some £8.9 million, made up as follows:

1. Capital	
Building and external works	£6.6m
Installations for tank testing	£0.2m
Foundations for large machine tools	£0.2m
Project management fee	£0.1m
Total capital	£7.1m
2. Revenue	
Machine move from Elswick	£0.4m
Redundancies	£1.4m
Total	£8.9m

The cost plan forming part of the CAR provided an estimate of building costs - excluding professional fees - of some £6.63m broken down as follows:

Main factory	29,924 sqm	£4,303,000
Offices	4,872 sqm	£ 974,000
Ancillary buildings		£ 148,000
External works		£ 541,000
		£5,966,000
Preliminaries		£ 622,000
Offices fit-out design fees		£ 45,000
Total	34,796 sqm	£6,633,000

The purchase of the site was not separately budgetted; this was eventually made on a sale and leaseback arrangement with Vickers Properties.

The tender sum submitted was:		£7,264,220
The contractor suggested savings of:	£771,490	
and provisional sums were reduced by:	£554,140	
		£1,325,630
The tender sum agreed was:		£5,938,580

DREADNOUGHT CAPITAL COST ESTIMATES/COST REPORTS

£000s
Date of estimate/report

	1981 Feb Budget *	Aug	Sep	Oct	Nov	1982 Jan	Feb	Mar	Apr	Aug
Main Dreadnought contract	£7,000	£5,939								
Fixed			£4,724	£4,724	£4,724	£4,724	£4,724	£4,724	£4,724	£4,724
Provisional sums			£1,334	£1,334	£952	£684	£562	£536	£545	£633
Bonus		£40	£40	£40	£40	£40	£40	£40	£40	£40
Employer's Instructions (EIs)			£10	£10	£112	£473	£547	£715	£739	£826
Request for Approval of EIs			£11	£11	£9	£3	£60	£13	£5	
Other			£3	£3	£9	£12	£51	£49	£92	£125
Total for main contract	£7,000	£5,979	£6,122	£6,122	£5,846	£5,936	£5,984	£6,077	£6,145	£6,348
Vickers direct exp										
Cladding	incl mc	£294	£294	£294	£294	£294	£294	£294	£294	£294
Cranes	incl mc	£320	£325	£325	£334	£334	£334	£334	£334	£334
Project management	£100	£205	£205	£205	£205	£205	£205	£205	£205	£375
Machine move	£400	£400	£400	£350	£350	£350	£350	£350	£350	£350
Electroplating shop	incl mc		£45	£45	£45	£45	£45	£63	£63	£63
Other		£173	£400	£400	£400	£624	£624	£700	£780	£395
Total for direct expenditure	£500	£1,392	£1,669	£1,619	£1,628	£1,852	£1,852	£1,946	£2,026	£1,811
TOTAL PROJECT COST	£7,500	£7,371	£7,791	£7,741	£7,474	£7,788	£7,836	£8,023	£8,171	£8,159

* Budget figures relate to the cost plan submitted with the CAR in February 1981